SEASONALITY AND BASIS ADJUSTMENTS IN THE FROZEN CONCENTRATED ORANGE JUICE FUTURES MARKET

By

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TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	ii
LIST OF TABLES	vii
LIST OF FIGURES	ix
ABSTRACT	xii
CHAPTERS	
I INTRODUCTION	1
General Theoretical Background	1
Futures Markets	5
Orange Industry and FCOJ Futures	8
The Problem	16
Research Objectives	17
Scope and Methodology	17
Overview	18
II LITERATURE REVIEW	20
Theory of Normal Backwardation of the Market	20
Storage Theory	25
Storage Cost Components	29
Physical storage costs	29
Convenience yield	30
Risk premium	31
Market liquidity	32
Determining Price Spreads and Storage	32
Emperical Uses	37
Parameter Variance in Regression Analysis	40
Causes of Parameter Changes	40
Models that Allow for Parameter Changes	41
The Cooley-Prescott Model	43
III REVIEW OF THE WARD-DASSE MODEL	46
Contributions of the Ward-Dasse Model	46
Basis Patterns	48
The Model Estimated	52
Model Specification	53
Risk Premium	56

		Page
	Convenience yield.	57
	Market liquidity	58
	Freeze bias.	59
	Freeze occurrence.	60
	Estimation and Results.	61
	Impact of Explanatory Variables Over Time	63
IV	REVIEW OF BASIS RESIDUAL MOVEMENTS	67
V	THEORETICAL ADJUSTMENTS TO THE FCOJ BASIS.	84
	General Analysis	84
	Storage Theory Analysis.	93
	Hypothesizrd Effect On the Ward-Dasse Model	96
	Convenience yield.	97
	Risk premium	100
	Market liquidity	101
	Freeze bias.	101
	Freeze occurrence.	102
	Hypothesized Dynamics of Market Adjustments	102
VI	ESTIMATION OF THE JULY BASIS MODEL	118
	Initial Estimates.	119
	Initial Specification	120
	Other Specifications.	128
	Final Estimates.	133
	Results and Review of Variable Definitions.	135
	Serial Correlation.	135
	Review of Estimation Problems.	139
	Interpretation of the Revised Ward-Dasse Model	142
VII	SPECIFICATION AND ESTIMATION OF CONSTANT PERIOD FROM MATURITY MODELS	148
	Constant Period Versus Constant Contract Models.	149
	Specifying a Constant Period Model for FCOJ.	152
	Accounting for Seasonal Fluctuatios	152
	Data Considerations	154
	Measuring Convenience Yield and Risk Premium	156
	Review of the Concepts.	156
	The Alternative Treatment	157
	Model Estimation	166
	Initial Model Specification	168
	Allowing for Dynamics and Seasonal Patterns	177
	Specification and Results.	177
	One period lags in the dependent variable.	178
	Yearly lags in the dependent variable.	183
	Yearly and one period lags in the dependent variable	184
	Other variations of the basic model.	185

Page

		Page
	The Final or Adopted Model.	186
	Accounting for seasonal differences. . . .	186
	Model specification and results.	189
	Alternative Specifications.	209
VIII	INTERPRETATION OF RESULTS OF CONSTANT PERIOD MODELS	214
	General Discussion	214
	Performance	214
	Lagged Basis Residual Variables	215
	Anticipatory Risk Premium	216
	Market liquidity and Freeze Effects	219
	The Basis Residual Variable	220
	Monthly Stock Effects.	221
	Stock Components.	222
	Freeze Bias Dominance	223
	Stock Effects Within Months	230
	Stock Effects Over the Year	233
	Dominance	236
	Understanding Differences in Monthly Stock Effects	240
	Long Run Stock Effects	245
	Seasonal Patterns.	247
	Basis Patterns at Different Stock Levels	249
	Taking a Constant Contract Perspective	256
	Low stock effect.	258
	High stock effect	261
	Average stock effect.	264
	Interseasonal convenience yield	266
	Basis Residual Changes Over Time	273
	Trends.	274
	Changes in Stocks	275
IX	IMPLICATIONS OF THE RESULTS.	278
	Theoretical Market Performance	278
	Stocks.	279
	Seasonal Patterns	280
	Imports	284
	Empirical Performance.	285
	Hedging Stradegies	290
	Expectations and Forecasting	293
	R-Squared and its Implications.	293
	The Lagged Basis Residual Variable.	294
	Simulating Basis Residual Adjustments	295
	Importance of Stable Parameters.	296

Page

X SUMMARY, CONCLUSIONS, AND RESEARCH SUGGESTIONS . 298

Summary. 298
Conclusions. 299
Suggestions for Research 301

APPENDICES

A TIME VARYING PARAMETER RESULTS 303

B COVARIANCE MATRICES. 307

LIST OF REFERENCES 323

BIOGRAPHICAL SKETCH. 326

LIST OF TABLES

Table		Page
3.1	The Ward-Dasse model results.	62
5.1	Review of relationships in the Ward-Dasse model .	109
6.1	Variable means and standard deviations for the 1967-68 through 1973-74 seasons (229 observations)	126
6.2	Variable means and standard deviations for the 1967-68 through 1981-82 seasons (489 observations)	127
6.3	Initial estimates of the July basis residual model over the original data period (1967-74) . .	129
6.4	Final estimates of the July basis residual model.	136
6.5	Review of variable definitions.	137
7.1	Initial constant period estimates	170
7.2	Variable definitions for the initial constant period model.	171
7.3	Results for a dynamic version of the initial constant period model	179
7.4	Results for the final version of the constant period model.	192
7.5	Variable means and standard deviations for the constant period model	193
7.6	Results for a non-dynamic version of the final model	213
8.1	Short run and long run effects of the crop forecast on the basis residual.	218
8.2	Estimated constant and monthly stock components for different periods from maturity	224
8.3	Categorizing months as risk premium, convenience yield, freeze , or risk premium - freeze bias dominant.	237

Table		Page
8.4	The constant and monthly long run stock components for different periods from maturity. .	246
8.5	Mean basis residual values by month for the different periods from maturity	267
8.6	Monthly comparison of average number of weeks of supplies held by processors	276
A.1	Time varying parameter results for the four month model	304
B.1	Covariance matrix for the six month model	308
B.2	Covariance matrix for the five month model. . . .	311
B.3	Covariance matrix for the four month model. . . .	314
B.4	Covariance matrix for the three month model . . .	317
B.5	Covariance matrix for the two month model	320

LIST OF FIGURES

Figure		Page
1.1	Imports of FCOJ by Florida Processors	10
2.1	The supply of storage curve and its components. .	34
3.1	Mean July FCOJ basis residual values.	49
3.2	Typical FCOJ basis residual for the July contract and key periods during the season	50
3.3	Interaction of explanatory variables in determining the July FCOJ basis residual	64
4.1	July FCOJ basis residual movements.	68
4.2	Four month from maturity basis residual movements based on various cash prices.	74
4.3	Various orange industry price movements	78
5.1	Hypothesized effect of unpredicted import increase on the model	105
5.2	Hypothesized change in the CY{t} coefficient over time	112
5.3	Hypothesized change in the RP{t} coefficient over time	113
5.4	Hypothesized change in the total freeze bias over time	114
5.5	Hypothesized change in the FZ{t} coefficient over time	115
7.1	Traditional view of the impact of stocks on the basis	159
7.2	Comparison of the log and inverse stock curves. .	161

Figure | Page

7.3 Predicted and actual basis residual values for the six month model 194

7.4 Predicted and actual basis residual values for the five month model. 197

7.5 Predicted and actual basis residual values for the four month model. 200

7.6 Predicted and actual basis residual values for the three month model 203

7.7 Predicted and actual basis residual values for the two month model 206

8.1 An example of freeze bias dominance 226

8.2 December stock effects for different periods from maturity. 229

8.3 Impact of stocks for different months to maturity during May. 231

8.4 Monthly stock effects for the five month from maturity model. 234

8.5 Stock effects relative to the May, two month effect. 242

8.6 Five month stock effect across the year given different S{t} values 244

8.7 The effect of stocks on seasonal basis patterns for the six month model 250

8.8 The effect of stocks on seasonal basis patterns for the five month model. 251

8.9 The effect of stocks on seasonal basis patterns for the four month model. 252

8.10 The effect of stocks on seasonal basis patterns for the three month model 253

8.11 The effect of stocks on seasonal basis patterns for the two month model 254

8.12 Comparison of seasonal effects across models given S{t} equals 0.8 257

8.13 Implied seasonal contract movements when S{t} equals 0.8. 259

Figure | Page

8.14 Implied seasonal contract movements when S{t} equals 1.2. 262

8.15 Implied seasonal contract movements when S{t} equals 1.0. 265

9.1 Stock effects across the year and across contracts 286

9.2 Representation of two contracts approaching maturity. 288

A.1 Likelihood function values for different values of the index of permanent parameter adjustment . . 305

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Basis models were estimated for frozen concentrated orange juice (FCOJ) (the basis is defined as the futures market's price minus the cash price). Primary concerns include the possibility of seasonal factors in basis patterns and the impact of increased importing and other economic developments. Storage theory was the primary theory used in the analysis.

The Ward and Dasse model of the FCOJ basis was updated. Comparison of the original and updated results reveals no obvious change in the impact of the original explanatory variables (one might hypothesize such a change given the recent increase in imports of FCOJ). Models were specified using a basis calculated using the futures contact that is a certain period from maturity, such as two months from

maturity. These models were estimated in a time varying parameter framework and no evidence of a change in parameters was found. The implication being that storage theory adequately represents the determinants of the FCOJ basis. The impact of recent developments is limited to their influence on explanatory variables, especially stocks, used in specifying FCOJ basis models.

To investigate the possibility of seasonal patterns in basis movements, models were specified and estimated with a set of monthly dummy variables interacted with an inventory variable. Stocks tended to have a more negative impact on the basis and the basis tended to be less towards the end of the Florida season (from about July to October). During this period inventories are generally decreasing since little or no fruit is being harvested. From December to February, the impact of stocks was less negative, resulting in a wider basis, as speculators bid up the futures price hoping to gain from a freeze.

CHAPTER I

INTRODUCTION

This study is concerned with modeling the frozen concentrated orange juice (FCCJ) basis (the basis is defined as the futures market price minus the cash price). Of particular concern are possible seasonal differences in basis movements and changes in basis patterns over time.

In this chapter discussions of theory and concepts useful in understanding futures markets, general information and theory about futures markets, the orange industry and the FCOJ futures market are reviewed. Finally, the problem, objectives, scope, methodology, and an overview of the study are presented.

General Theoretical Background

Economics is often described as a social science that addresses the allocation of scarce resources among competing ends (Ferguson and Maurice, 1974). Prices play a key role in this allocation process. In a market economy relative prices provide a measure of society's relative valuation of goods. A change in society's valuing is an impetus to change in relative prices. Prices that do not reflect

social valuation will tend to adjust as suggested by this valuation as time progresses.

Efficiency considerations, based on the value of inputs and the expected price of output, result in production decisions as to the relative proportion of inputs used and the level of output. Over time, relative prices also dictate the technology employed. In the final goods market supply and consumers' demand interact to determine price, with the individual consumer allocating his/her income among alternative goods so as to maximize their total usefulness. Prices that allow for excess profits will tend to motivate entry into these profitable endeavors to the extent that entry is possible. If there are no barriers to entry, then the price received for a product will tend to equal the value of the various inputs used. Thus, prices not only serve an allocative role but also promote efficiency. Distribution of a product across regions and decisions as to the final form of a product provide further examples of the allocative and efficiency functions of price.

The concern of this study is the role that prices play in the efficient allocation of goods across time. Consider a storeable agricultural good that is harvested during a short period each year, with consumer demand existing throughout the year. Knowledge of future demand and potential profit creates an incentive for storage that will affect the price of the good at harvest. Without storage,

the harvest price could be relatively depressed; the presence of a demand for storage at harvest will bid up this price and provide a means for future consumption. Over time competitive adjustments in the level of storage and prices will result in price differences over the season reflecting the various costs and risks associated with storage; efficient allocation is achieved when the price at a point in time is equal to the value of the product at harvest plus incurred storage costs following the harvest period. To the extent that future conditions are not predictable, efficient allocation as addressed above is not possible. A shift in demand, for example, can result in a current price that is less than the harvest price despite storage costs.

This example points toward the fact that the present market or spot price is not only a function of current conditions but also future and potential future circumstances. An anticipated change in future conditions, and thus future prices, will influence the release of the good from storage to the market and influence the spot price. An efficient response to such a change in future conditions will result in spot price, anticipated future spot prices, and inventories adjusting such that the difference in spot and anticipated prices equals the value of the various costs and risks associated with storage. If an anticipated change such as a large crop implies that prices must decline at some point in the future or not

increase to the extent necessary to cover costs, then supplies are allocated in the interim using the above criteria and the added condition that current and forthcoming supplies before the large crop be exhausted at the time of its harvest (ignoring convenience yield considerations which are discussed in detail later). Such a criterion for allocative efficiency across time is primarily of academic interest since accurate prediction of future conditions is difficult. However, it does give insight into how an efficient market will respond to information regarding the future. The stabilizing influences of storage on prices over time are constrained by the inability to predict future conditions with certainty.

Even with storage's stabilizing influence, changing conditions can cause significant price adjustments, especially for agriculture commodities. The risk associated with possible unforeseen price changes creates an incentive for the farmer, for example, to establish a forward price for the crop prior to planting. The use of such forward contracting, by removing price uncertainty, increases the producers' and distributors' ability to make intelligent production and/or marketing decisions. Price certainty increases the ability to make a concrete assessment of the worthiness of the business endeavor which will tend to make financing easier--both outside and owner financing (Kohls and Downey,1972). By reducing the financing constraint, the

producers, processors, and distributors are in a better position to organize their operations and produce at a scale that is most efficient. The most likely candidate for the farmer to enter into a forward contract with is the next level in the marketing chain. A processor, for example, might be motivated to buy forward in order to insure efficient plant operation and to coordinate both buying and selling functions. By buying forward, a processor would be able to contract to sell forward to the next marketing level with minimal price risk.

Futures Markets

Disadvantages of forward contracting have led to the evolution of futures markets (Kohls and Downey, 1972). Forward contracting can involve significant search costs in bringing buyers and sellers together (see Behr, 1981). Once brought together, it is possible that one of the participants is in a position to exert market power, leading to an unfair price. Difficulties associated with transferring contract obligations to a third party can make it difficult to optimally deal with changing conditions.

Futures markets provide a organized exchange to buy and sell contracts for specific commodities deliverable at a specific future date. The contracts are transferable, providing the trader an option to make or take actual delivery. For example, a farmer may sell October futures in April (establish a commitment in April to make a delivery

in October). The delivery commitment can be cancelled by buying back the contract before the October deadline. In practice the vast majority of contracts issued do not result in actual delivery. Actual delivery will not occur in the example above if when buying forward the farmer buys a contract from someone who had originally taken a opposite position. The independent actions of each cancel each other out.

To facilitate such exchanges requires standard contracts that include minimum quality specifications. Since typically most of the product produced will exceed these minimum standards, some potential traders may be discouraged to use the market. The lack of such a quality constraint and other constraints imposed by the standardized future contract are advantages of forward contracting in contrast to futures. However, the option of reversing one's original position prevents quality considerations from being a major deterrent to futures trading.

Efficient use of the futures market as a means to reduce price risk requires knowledge of how the specific spot and futures prices tend to be related over time. Hedging, or the commercial use of futures markets to reduce price risk, involves taking a position in the futures market that is opposite but not necessarily equal to the positions taken in the cash market.

The difference between the futures and the spot price is called the basis. Movement in the basis over time generally determines the effectiveness of a hedge. If the basis remains unchanged complete transference of price risk has occurred. Generally, changes in the basis are to be expected. A narrowing of the basis is to the advantage of the short hedger (short meaning that he originally sold forward). A widening of the basis is to the advantage of the long hedger (long meaning that he originally bought forward). To effectively hedge requires an understanding of how the basis tends to change over time. Since the basis reflects the difference in prices at two points in time, storage theory should provide an accurate understanding of basis movements if the market is performing efficiently and the contract is for a storeable commodity. If the basis is totally unpredictable, then the futures market is of limited use as a hedging tool.

In addition to providing a means for hedging, it is often argued that the futures market may affect the variance in spot prices across time by lessening seasonal fluctuations in prices and reducing the magnitude of price changes from one season to the next. Gray (1962), for example, in studying the effect of the onion futures market found the market to have a stabilizing influence on prices. Such stabilizing influences would result if spot markets were imperfect in processing and responding to information

about future conditions. An expected increase in future prices, for example, should be reflected in an increase in the storage component of current demand and therefore bid up the spot price if the spot market is efficient.

Some argue that futures markets can result in a bidding up of the cash price (see Dasse, 1975). That futures market prices are often used in establishing a cash price is true. However, such practices also reflect a consensus as to the unbiasness and informational value of a futures' price (Kohls and Downey, 1972).

The ramifications of a futures market that is not operating efficiently can be severe, resulting in ineffective hedging and possible distortions in prices. Ideally, a proper mix of hedgers and speculators is needed. Participants must also be aware of how the basis behaves in order to hedge intelligently. Attention must be focused on any new developments in the industry and how these developments might affect the basis and thus individual trading strategies. These developments must also be manifested in futures prices and basis movements for the market to be performing efficiently.

Orange Industry and FCOJ Futures

Recent developments in the orange industry point toward the significance of basis pattern adjustments to changing conditions and the need for traders to keep abreast of the adjustments. Significant increases in the amount of FCOJ

imported by Florida processors, depicted in Figure 1.1, have potentially decreased the impact of domestic orange availability on domestic FCOJ prices. Coinciding with increased imports by Florida processors has been an increase in imports by firms outside of Florida. The possibility of imports being used to substitute for domestic fruit losses due to a freeze lessens the potential effect of freezes on prices. Such circumstances represent a fundamental change in the industry.

It is reasonable to suspect that increased importing and coinciding developments, cited below, have influenced pricing throughout the industry. Changes in pricing should, given an efficient futures market, influence FCOJ futures prices and may well impact basis movements. Any knowledge of changes in the determinants of basis movements would be an aid to hedgers in formulating trading strategies.

The relatively large swings in FCOJ prices due to freeze losses is rather unique for commodities exchanged on the futures market and result in relatively unusual basis patterns. Of particular concern is what Ward and Dasse (1977) refer to as the freeze bias which is a bidding up of futures prices relative to spot prices by speculative traders during the freeze period and immediately preceding it. No empirical studies on the magnitude of the freeze bias during months preceding December have been reported. Ward-Dasse found a decline in the freeze bias from the

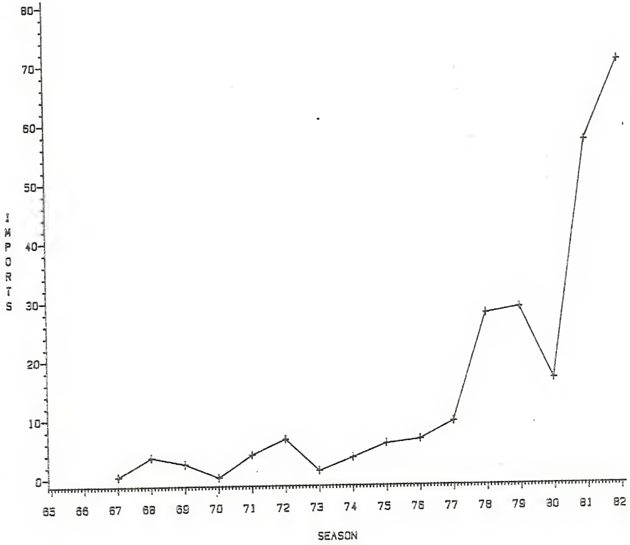

Figure 1.1. Imports of FCOJ by Florida processors (millions of gallons)

beginning of December until the threat of freeze has past in mid-February. The freeze bias can be viewed as an anticipatory phenomenon, reflecting some averaging of future prices that are expected to exist without a freeze with future prices that would probably exist with freezes of various intensities. To the extent that the freeze bias over time reflects the average price for the contract of concern, there will be no pay off to speculators; gains in freeze years are offset by loses in other years. Due to the freeze bias, hedgers will not only transfer price risk but also tend to profit since the basis will tend to narrow after the freeze period has passed, whether or not a freeze has occurred. The possibility of other seasonal factors influencing FCOJ basis movements has not been reported.

The influence of imports on FCOJ prices, especially during freeze years, is of direct concern to traders. Understanding how the basis has reacted to the recent increase in imports should provide insight into the affect of future import conditions on the basis and thus provide for more enlightened hedging.

That the wholesale price or FOB price of FCOJ is an administered price is also relatively unique among commodities traded on futures markets. Price leadership may be used to coordinate price changes by processors. Processors generally change prices within a week of each other.

The associated phenomena of administered pricing and possible price leadership suggest the possibility that processors exert market power and that an imperfect market for FCOJ exists with prices tending to be greater than marginal costs. From the standpoint of allocative efficiency, oligopolistic or imperfect markets are inefficient since the resulting price is greater than the value of the inputs used, resulting in excess profits at the expense of consumers. However, price leadership can also result in competitive pricing decisions over time in the sense that there are no excess profits (Scherer,1970).

Possible price leadership and oligopolistic practices make analysis of the role of imports more difficult than for most agricultural industries. Factors leading to increased importing include greater Brazilian orange production and a shifting of domestic consumer demand to the right. Increased imports complicate analysis of domestic pricing. Information on how prices and basis movements have been influenced in the past by imports would be useful to FCOJ futures traders, especially if imports should continue to increase.

Given that over 90 percent of Florida's orange crop is processed and over 90 percent of the processed product is marketed as orange juice suggests that developments that affect FOB prices have significant ramifications for all prices in the industry (Florida Citrus Mutual, 1982). The

seasonal nature of orange production and supply uncertainty have resulted in FCOJ inventories being a major factor in pricing decisions. Given that imports provide for an alternative supply, accelerated imports imply a potential decrease in the significance of inventories. Inventories are of key importance to understanding the allocation of a good over time since inventories provide the link between the present and the future. Basis movements are often conceptualized as being a function of inventories. Documentation of any change in the relationship between imports and the basis would be helpful to FCOJ futures traders.

Increased import availability may also decrease the price that processors are willing to pay for domestic fruit. Coinciding with increased import availability has been a trend towards increasing production and sales of chilled orange juice (COJ) and the establishment of non-Florida processors that import and reprocess these imports into COJ and other orange juices. The increased competition offered by these processors may affect the profitability of Florida processors, the various orange juice prices, and ultimately all prices in the industry.

Industry practices point toward the significance of the wholesale FOB FCOJ price as a determinant of other prices and as the key to understanding movements in all related prices. Orange juice inventories are often carried in 55 gallon drums which are referred to as bulk FCOJ. Large tank

farms are also used for storage. Only bulk FCOJ is traded on the FCOJ futures market. Bulk may be reconstituted and sold as COJ, sold as bulk to other processors, used to meet future market commitments, or repackaged into retail and institutional packs. Sales of CJ have increased dramatically in the last decade and today the markets are similar in size (comparison refers to the fluid equivalent of FCOJ) (Florida Citrus Mutual, 1985). Bulk prices will tend to vary more than wholesale FOB prices among processors, reflecting not only differences in quality of the bulk but also differences in individual processors inventory conditions. On an industry level, bulk will typically be discounted to retail pack when inventories are relatively high (Ward and Kilmer, 1980). Demand theory suggests that such discounting can be explained by the difference in demand elasticities for the bulk and retail-size markets. Discounting of bulk tends to last for short periods of time. Such transitory price changes suggest the wholesale FOB price and not the bulk price is more indicative of pricing that is to exist in the future. Orange juice imports are in the bulk form and primarily, if not totally, from Brazil.

Less than 20 percent of Florida's oranges are marketed on the spot market (Florida Canners Association, 1980a). Most oranges are marketed through cooperatives or private participation plans. Those that market through

participation plans are compensated base on FOB prices. Cooperative members are directly affected by the profitability of processing. Intuitively one would expect the spot price, the participation plan price, and the implied price of fruit paid cooperative members to have similar values over time since a heavy discounting of one would result in growers eventually opting for the other forms of marketing. Historically, the grower who markets fruit on the spot market will tend to incur a substantial premium when processor's inventories are low or crop size has been reduced by a freeze and a substantial discount when inventories are high or crop size is heavy (Ward and Kilmer, 1980). Importing may impact this historical relationship somewhat, and thus the marketing margin and basis movements calculated using the spot price. Imports provide processors an alternative to buying on the spot market.

The importance of the wholesale FOB price of FCOJ results in many using it in their reflections about the FCOJ futures market. Since the wholesale price is rigid, using it as cash price in basis calculations results in a basis that changes more often due to changes in the futures price than due to changes in the cash price. Rigidity in wholesale FOB prices often results in a delayed price response to changing conditions. Accurately predicting conditions, such as an increase in demand, does not

necessarily imply that these conditions will be reflected in the price for the period that the futures trader is concerned with. Alternatively, the keen trader, realizing that conditions have changed since present FOB price was set, is in a better position to predict future prices than one who views present price as indicative of present conditions.

The Problem

Accelerated importing of FCOJ has potential implications throughout the U.S. markets. The traditional role of inventories as the processors' main asset in dealing with uncertainty may be altered as imports provide a substitute for domestic fruit and inventories. Coinciding with increased imports has been an increased market share for COJ and the establishment of non-Florida processors that use imports in the production of COJ. Such developments may well impact pricing throughout the industry. Of particular concern is the possibility of using imports to substitute for fruit lost in freezes and the impact such substitution has on domestic prices. Previous estimates of FCOJ basis movements may no longer be valid. To best use the futures market for FCOJ, hedgers need to know what the implications of changing stocks (domestic and imported) and coinciding changes on basis movements have been.

Research Objectives

The overall objective of this study is to provide an increased understanding of adjustments in the FCOJ futures market within the year due to seasonal factors and across years due to industry developments such as importing. The specific objectives are

(1) Provide theoretical models of the FCOJ basis.

(2) Provide a theoretical understanding of the possible impact of increased imports on the FCOJ futures market.

(3) Specify and estimate FCOJ basis models that address the potential impact of recent trends in stocks.

(4) Based on the estimated models and theory delineate the implications that the empirical results have for users of the FCOJ futures market.

Scope and Methodology

This research is concerned with the FCOJ futures market as a means for forward contracting for the U.S. orange industry. A main concern is the potential adjustments in industry practices and especially basis patterns that have resulted from the increased role of importing and coinciding events. Theoretical considerations, to be presented in Chapter V, point to the possibility that such importing implies a structural change in the industry. The Ward-Dasse basis model, originally estimated before the increased role

of imports, was estimated over the original and an updated period using weekly, time series data for the July contract. These models were estimated using ordinary least squares. Basis models were also estimated using dependent variables based on the basis for contracts that were two through six months from maturity (constant period from maturity models). These estimates will provide additional insight into any continuous adjustment of the basis over time. These basis models were estimated in a time varying parameter framework with model specification being motivated by the Ward-Dasse model which attempts to explain basis patterns using storage theory. The July contract was not estimated in a time varying parameter framework due to the time discontinuity associated with switching from one contract to the next after contract maturity. The two through six month from maturity models encompass the entire year, while the July basis models only covered the December through July period. In specifying and estimating the two through six month models, the possibility of seasonal factors in addition to the freeze bias was considered. Data concerning conditions in Florida and the inventory situation of Florida processors was used since FCOJ futures market delivery points are only located in Florida where the vast majority of U.S. orange processing takes place.

Overview

Chapter II reviews theoretical literature, empirical studies, and econometric procedures. The Ward-Dasse model, which is estimated in various forms in this study, is reviewed in Chapter III. A graphical history of FCOJ basis patterns and industry prices is presented in Chapter IV. In Chapter V the theoretical implications of imports and coinciding developments are reviewed. The results of re-estimating the Ward-Dasse July basis model over the original and an updated data period are presented in Chapter VI along with an interpretation of these estimates. In Chapter VII fixed or constant time from maturity models are considered. The rationale behind the specifications and the results are included. An interpretation of the estimated basis models is presented in Chapter VIII. In Chapter IX implications of the study are reviewed. Chapter X serves to summarize, review conclusions and point toward potential avenues for future research.

CHAPTER II

LITERATURE REVIEW

Two topics are reviewed in this chapter: basis theory and time varying parameters. The discussion of basis theory is divided into two sections. First, a short review of the theory of normal backwardation is presented. Then, the storage theory approach, the theoretical framework used in this study, is reviewed.

Theory of Normal Backwardation of the Market

The first complete theory of basis patterns, the theory of normal backwardation of the market, was introduced by Keynes (1930). Kaldor (1939) and Blau (1944-45) expanded the theory, presenting it in a more rigorous and complete framework. Hicks (1946) presented supporting arguments. The theory as it is discussed today is usually attributed to Keynes and Hicks though other authors have made important contributions. The main purpose of reviewing the theory here is that there is often confusion between risk premium as it is used in the theory of normal backwardation and how it it is used in storage theory. By pointing out the difference in risk premium, as it applies to these two theories, it is hoped that confusion can be avoided.

"Backwardation" is an English term that refers to the current spot price being above the futures price. The American counterpart is an inverted market or an inverse carrying charge. The futures price being above the spot is called "contango" by the English and implies a positive carrying charge to Americans. English terms are usually used in discussing the theory of normal backwardation and American terms are used in storage theory, in keeping with the terms used by the original authors.

The theory of normal backwardation states that the difference in the expected spot price in the future and the current spot price equals marginal net carrying costs. Given uncertainty, carrying costs include physical storage costs (rent, fire insurance, electricity, etc.), convenience yield and risk premium. Interest costs are also often included separately or included with physical storage costs. Some refer to physical storage costs as carrying costs or simply storage costs--these terms are not used in this manner here but are used as equivalents for carrying costs.

The convenience concept was introduced by Kaldor (1939) and helps explain the current spot price being bid up relative to the futures price. Given low stocks, benefits are gained and costs often avoided by adding to inventories. When stocks are relatively low, the current price will tend to be pushed up relative to the futures price to compensate stock holders for the yield associated with holding additional stocks.

The risk premium reflects the tendency for the expected price in the future to be higher due to uncertainties. In order to carry stocks, some protection must exist to protect against unforeseen price movements. Thus, anticipated prices in the future include a risk premium component. The greater the stocks held, the more the risk faced and thus the greater the risk premium and the expected price in the future.

Risk premium and convenience yield are also used in storage theory and are reviewed in greater detail when storage theory is discussed and throughout the study.

In equilibrium futures prices do not include a risk premium component and will be lower than the expected spot price, which does include a risk premium component, by the amount of the marginal risk premium. Thus, the futures price is downwardly biased to the extent that the anticipated price does reflect a risk premium. This result is due to the actions of short hedgers, who are willing to sell at the lower, biased futures price in order to avoid any price risk. Short hedgers, in effect, pay to long speculators an amount equal to the risk premium. As maturity approaches, the futures price will tend to increase because the risk premium is less, due to less uncertainty associated with the shorter time to maturity. Thus, most often long speculators can reverse their position and make a profit in payment for bearing the risk of unforeseen price

movements. Given normal stock levels and no expected price change, these conditions imply

$$
\begin{aligned}
(2.1) \qquad p^* &= p \\
f - p &= w'(s) - c'(s) \\
p^* - p &= w'(s) - c'(s) + r'(s) = 0 \\
f &= p^* - r'(s)
\end{aligned}
$$

where

p^* = expected spot price in the future,

p = current spot price,

f = futures price for period corresponding to p^*,

w = physical storage costs,

c = convenience yield,

r = risk premium,

s = stocks,

$'$ denotes marginal.

Thus, given the typical conditions of no anticipated change in prices, there is a normal backwardation in the market. The spot price is greater than the futures price by the amount of the risk premium. Arbitrage and the willingness of short hedgers to accept a futures price that does not reflect the risk premium will tend to push the market towards these equilibrium conditions (Venkataramanan, 1965).

If the expected price is less than the current spot price, due to a relatively low level of stocks and thus a strong convenience yield effect, abnormal backwardation of the market will result with the difference in the futures

price and the current spot price being more than the amount of the risk premium. These conditions imply

$$(2.2) \quad p > p^*$$

$$f - p = w'(s) - c'(s)$$

$$p^* - p = w'(s) - c'(s) + r'(s) < 0$$

$$c'(s) > w'(s) + r'(s)$$

$$f = p^* - r'(s)$$

$$f < p - r'(s) \text{ (abnormal backwardation).}$$

If the futures price is greater than the current spot price a contango is established. Such a condition implies a low or zero convenience yield since stocks will be relatively high. In equilibrium, the maximum amount that the futures price will exceed the current spot price is equal to marginal physical storage costs. A risk premium still exists and is paid or forfeited (depending on the perspective one wishes to take) by the short hedger. The futures price is less than the expected spot price by the amount of the risk premium. The small convenience yield effect implies that the current spot price will be lower than the expected price by more than the normal backwardation. These relationships are reviewed below

$$(2.3) \quad f > p \text{ (contango)}$$

$$p^* > f$$

$$p^* > p$$

$$f - p = w'(s) - c'(s) \simeq w'(s) \quad \text{(since the convenience yield is small or zero)}$$

$$p^* - p = w'(s) - c'(s) + r'(s) \simeq w'(s) + r'(s)$$

$$f = p^* - r'(s)$$

$p < p^* - r'(s)$ (current price is below expected price by more than the level of normal backwardation).

The high level of stocks above also implies that the marginal risk premium will tend to be greater than for the other examples (Venkataramanan, 1965).

Slight variations on the theory as described above are also in the literature. Often the impact of stocks is not emphasized. A review of key points follows. The current spot price and the expected spot price for the future differ by the amount of carrying costs. The futures price does not reflect the risk premium component of total carrying costs and is thus downwardly biased. Short hedgers are willing to accept a futures price that does not reflect the risk premium in order to reduce their risk. As maturity approaches the basis will tend to wider due to increased futures prices, associated with a decreased risk premium, resulting in a profit to long speculators.

Storage Theory

Criticisms of the theory of normal backwardation of the market tended to focus on the validity of assuming a biased futures price and the accuracy of its portrayal of hedging interests. Others question the realism of assuming variables that represent some consensus, such as expected spot price or the value of the risk premium. The impact of long hedgers is not considered. Thus, the usefulness of the

theory for markets or periods when long hedging is important is questionable. Working (1948,1949) and others, such as Telser (1958), argue that future prices do not have a negative bias.

Working (1948, 1949, 1960) argues that hedgers are motivated by more than a desire to reduce risk in their use of the futures market. Hedging, according to Working, is also a manifestation of the profit motive. Profit can be realized by favorable basis movements. Furthermore, he felt that hedgers are more apt to use the market when they believe that basis movements are relatively easy to predict and when they expect to receive a premium or make a profit. Working argued that often the use of the futures market by hedgers is part of their overall merchandising scheme, with the futures contract only representing a temporary substitute for a merchandising contract. Trading will also occur to simplify decisions and to cut costs. The theory of normal backwardation's view that short hedgers would tend to suffer a loss did not sit well with Working and his wider view of hedging.

Storage theory is credited to Working (1948, 1949). The theory is also often called carrying cost theory, the theory of inverse carrying charges, and the theory of the price of storage. The theory is more compatible than earlier theories with Working's expanded view of hedging. Emphasis is placed on the unity between the cash and the futures

market. They are not viewed as two different markets but one market for the same good across time. The futures price is not biased, except when liquidity problems or unbalanced market conditions exist. Arbitrage works equally well when the futures price minus the current spot price is less than or greater than storage costs (also referred to as carrying costs or the price of storage). In equilibrium, the futures price minus the spot price equals carrying costs and the futures price equals the expected price. Working paid close attention to wide fluctuations in the spread between futures and cash prices and emphasized that this spread was determined by the market. Stock levels were viewed as the key in determining the spread.

Brennan (1958) follows Working and presents Working's basic ideas in a more general framework. Brennan shows that the determinants of the futures price or the basis are also at work in markets with no futures market. Storage occurs in these markets with an expected or anticipated price for the future in mind, as suggested by profit maximization (the expected price and the futures price are analogous since the futures price is not biased). Brennan found it necessary to postulate a risk premium. Working did not explicitly include such a concept in his main works. A major difference of opinion on the risk premium does not appear to exist between the two authors. Working was attempting to upset the risk premium concept as it was used previous to

him. Brennan's use of the risk premium concept does not imply a biased futures price and thus it is not at odds with the main thrust of Working's arguments. Brennan's viewpoint being more general and explicit has the advantage of easily tracing through the implications of changes in market conditions such as demand and supply changes. By removing the risk premium from Brennan's model, the implications are the same as those using Working's viewpoint.

The equilibrium conditions for storage theory, allowing for a risk premium, using the notation developed in the last section are

$$(2.4) \qquad p^* = f$$

$$p^* - p = f - p = w'(s) - c'(s) + r'(s).$$

That is the futures price minus the spot price (the basis) equals the marginal carrying cost (also called the price of storage or storage costs), which has the components marginal physical storage costs, marginal convenience yield, and marginal risk premium. The major difference when compared to the theory of normal backwardation is that the futures price does reflect the risk premium and is not biased. No premium is paid to speculators (this is upsetting to some who wonder how speculators get paid (Cootner, 1960) to which the reply seems to be that they have different attitudes towards risk and/or are better forecasters of future prices or at least think that they are better forecasters). The risk premium plays no part in causing an inverted market,

which is due entirely to the convenience yield at low stock levels. Thus, more emphasis is placed on the convenience yield than in earlier theories, which also used the risk premium to help explain inverted market. The role of stocks receives much more emphasis also. Generally, one can expect the basis to approach zero as maturity approaches; each component of total carrying costs will tend to have less of an impact as maturity approaches.

Arbitrage will tend to result in storage and price adjustments until the equilibrium conditions are reached. A more thorough discussion of the components of storage costs is presented next, followed by how demand and supply for storage interact in allocating goods over time. Finally, empirical uses of storage theory are discussed.

Storage Cost Components

Essential points regarding the concepts that comprise total storage costs are reviewed below. Other points are discussed later in the study.

Physical storage costs. All costs associated with storage and not addressed by the other components are included under physical storage costs. All costs that have to do with the actual storage operation are included, such as rent, electricity, fire insurance, and similar expenses. Usually interest costs associated with the investment are included, though they may be treated as a separate

component. Similarly, delivery costs associated with fulfilling a futures commitment are included or treated separately. In modeling the FCOJ basis delivery costs are of minor importance since all delivery points are in Florida.

<u>Convenience yield</u>. Kaldor (1939) introduced the convenience yield concept to help explain the occurrence of an inverted market, that is the cash price being greater than the futures price. The concept, later refined by Working (1949) and Brennan (1958), states that when inventories are sufficiently low, holders of stocks gain a yield from holding rather than selling these stocks. This yield provides the holder of stocks a rationale for continuing to hold stocks rather than selling them on the cash market when the cash price is above the futures price. If inventories should fall too low, the holder of stocks may experience inefficiencies in operation, potential loss of customers due to insufficient supplies, and the inconvenience of continuously replenishing stocks. Generally, these possibilities imply losses in future revenues or additional future costs that result from having stocks fall below some threshold level. Blau defines convenience yield as "the sum of extra advantages (other than appreciation in the market value) which a manufacturer may derive from carrying stocks above his immediate requirements himself rather than holding the equivalent

value in cash and buying stocks at a later date" (1944-45,p.6). The yield from holding stocks does not necessarily arise from consideration of storage concerns alone. Storage facilities and ownership are often intertwined with selling and/or processing operations, leading to a wider perspective.

Given that stocks are sufficiently low, convenience yield serves to shift the supply of storage to the right. Convenience yield considerations result in less being offered on the cash market and more being held in storage than would occur without such consideration. The lower the level of stocks on hand, the greater the convenience yield and the greater the shift in the supply of storage.

Risk premium. Holders of stocks face a risk associated with unexpected price movements. The risk premium serves to compensate stock holders for bearing this risk and thus increase the motive for carrying stocks by bidding up the expected price for the future. The greater the level of stocks held, the greater the level of risk faced and thus the greater the risk premium and expected future prices. The risk premium is the most controversial of the components included under carrying costs. Empirical findings are mixed; evidently some commodities have a risk premium and others do not (Brennan,1958; Working,1949). If a risk premium is not included, then difficulties are encountered in attempting to explain a futures price that is greater

than the spot price by more than physical storage costs. The major difference between storage theory and the theory of normal backwardation is that the theory of normal backwardation does not include the risk premium in the futures price, while storage theory does. Futures prices tend to be downwardly biased according to the theory of normal backwardation, while they are unbiased according to storage theory.

Market liquidity. In that equilibrium is not always the case, market liquidity variables or similar variables measuring the extent of trading are often included in empirical studies. The rationale is that if trading is low, then the current futures price may not be representative of expected future conditions.

Determining Price Spreads and Storage

Physical storage costs, convenience yield, and risk premium determine the implied cost for each firm for carrying a particular level of stocks. The relationship between these costs and stocks is the firm's net marginal storage cost function. Profit maximization given pure competition insures that the marginal storage costs per unit of time associated with a particular level of stocks is equal to the expected price change. (Generally, imperfect markets for a good over time are not possible since it is not possible to segregate time periods. If price

differences over time do not reflect marginal costs, then incentive exists for individuals to purchase the good when it is priced relatively low and resell it when it is priced high.) Convenience yield considerations allow for stocks to be carried given an expected price decrease. The industry's supply of storage curve is the horizontal summation of each firm's net marginal cost function. A typical industry's supply of storage curve, suggested by Brennan (1958), and its components are portrayed in Figure 2.1. Marginal storage cost (m') is the sum of the components of storage and is defined

(2.5) $m'(s) = w'(s) - c'(s) + r'(s)$

Working addressed a similar curve but did not explicitly note marginal risk premium. Note that marginal convenience yield is subtracted since ignoring the yield in determining stocks carried is analogous to forgoing a return (some conceptualize this yield as a cost -- a yield can be viewed as a negative cost). Plotted is -c'; the lower the level of stocks, the more current prices will tend to rise relative to future prices in order to compensate holders of stocks for allowing inventories to decrease. Marginal physical storage costs (w') are assumed constant, until after some point they begin to rise. This point is after the industry's usual warehouse capacity is almost exhausted. Similarly, marginal risk premium (r') may accelerate quickly after some point. This point occurs once additional stocks

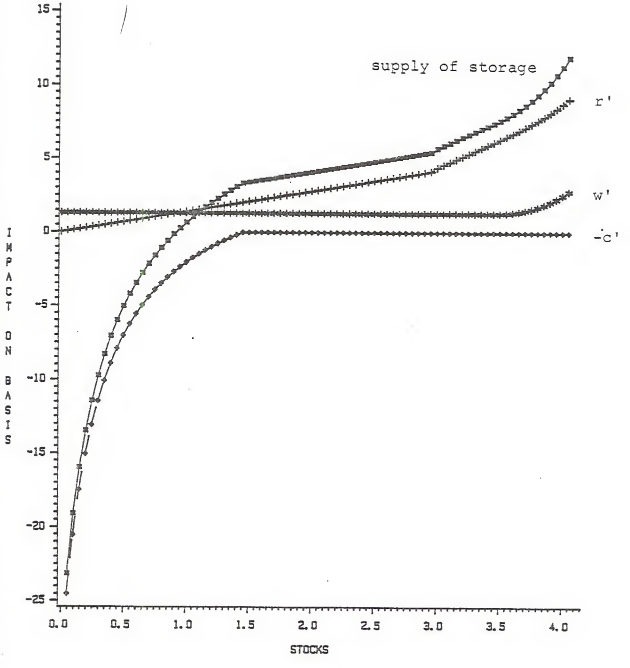

Figure 2.1. The supply of storage curve and its components

held could result in serious damage to a firm's credit and financial condition if an unexpected price change should occur. It is possible that marginal risk premium will be constant over some range of stocks. The level of stocks associated with the acceleration of w' and r' will be rarely held in most industries and might not occur in practice.

It is important to note that Figure 2.1 represents some particular point in time. As maturity approaches, the impact of each of the components of total carrying costs will decrease when the same stock levels are compared. At maturity the equilibrium condition is for the basis to equal transportation costs assuming identical qualities.

To aid in understanding the level of stocks carried and differences in prices over time, Brennan (1958) discusses the demand for stocks in a two period model. The price during any period is a function of the quantity demanded. This quantity can come from the amount produced in that period or from inventories. The following relationships are suggested where {} implies a subscript

(2.6) P{t} = f{t} (C{t}), ∂(f{t}) / ∂(C{t}) < 0,

C{t} = S{t-1} + X{t} - S{t}

P{t} = f{t}(S{t-1} + X{t} - S{t})

where

P{t} = price in period t,

C{t} = consumption in t,

S{t-1} = stocks at the end of period t-1,

X{t} = production during t,

$S\{t\}$ = stocks carried out at t.

If, for simplicity, one assumes that current and future production levels and stocks are known, then it is possible to isolate the importance of carryover ($S\{t-1\}$). If carryover is increased, current prices must decrease and less will be consumed. More will be available for sale in the future. Assuming future stock and production levels are fixed, prices in the future must decrease relative to the case when carryover is not increased.

The demand for storage from period t to t+1 is represented by Brennan (1958) as

$$(2.7)\quad P\{t+1\} - P\{t\} = f\{t+1\}(C\{t+1\}) - f\{t\}(C\{t\})$$
$$= f\{t+1\}(S\{t\} + X\{t+1\} - S\{t+1\}) - f\{t\}(S\{t-1\} + X\{t\} - S\{t\}).$$

Differentiation with respect to $S\{t\}$ reveals the price spread is a positive function of $S\{t\}$. If $S\{t-1\}$, $X\{t\}$, $X\{t+1\}$, and $S\{t+1\}$ are considered fixed or exogenously determined, then the price spread is a positive function of $S\{t\}$.

The equilibrium quantity of stocks held can be found by setting marginal storage costs equal to the expected price in the future minus the current price.

$$(2.8)\quad w\{t\}' = E\,P\{t+1\} - P\{t\}$$

where

$E\,P\{t+1\}$ = expected price in t+1.

Shifting the demand for storage curve to the right, by changing an exogenous value, will increase the price spread. Shifting it to the left decreases the spread.

Brennan's assumptions do not appear too restrictive to prevent some general statements from being made. The amount of stocks carried over will not only affect present prices but also future prices. Thus, stock holders will influence prices over time by the level of stocks they carry. Profit maximization over time implies that carryover is sensitive to or determined by anticipated future conditions. Future events, for example, an anticipated shift in demand or production, will influence anticipated future prices, the current price, the spread, and stocks carried.

Empirical Uses

Given that the supply of storage curve has remained constant over time, it is possible to use regression analysis to measure the impact of stocks and other explanatory variables. Such an approach assumes that differences in the basis over time are due to changes in the demand for storage and that the observed basis is in equilibrium. Market liquidity variables are often included to account for departures from equilibrium.

Brennan (1958) regresses a function of stocks against the basis residual to measure both the impact of convenience yield and risk premium on the basis. The basis residual is the basis minus physical storage cost and implied interest

expenses. Definitions similar to the following are typically used

$$
\begin{aligned}
(2.9)\quad B\{t\} &= F\{t\} - P\{t\} \\
BR\{t\} &= B\{t\} - M\{t\} \\
M\{t\} &= PS\{t\} + (P\{t\})(\exp(rt) - 1)
\end{aligned}
$$

where

- $B\{t\}$ = basis in t,
- $F\{t\}$ = futures price,
- $P\{t\}$ = cash price,
- $BR\{t\}$ = basis residual,
- $M\{t\}$ = total storage and interest costs,
- $PS\{t\}$ = physical storage costs,
- r = market interest rate,
- t = length of time until the futures contract matures.

The futures price used may be the price for a specific contract, such as the July contract, or the price of the contract that is a fixed time away from maturity, such as two months from maturity. Physical storage and interest costs are usually subtracted from the basis since they are observable. Such a practice is analogous to restricting their coefficients to equal one as suggested by theory. Other variables, such as convenience yield and risk premium, are not observable. Implications as to their magnitude and significance can be gained by regressing their operationalizations against the basis residual. (Note that the estimated model may be referred to as a basis model or a

basis residual model.) Ward and Dasse (1977), reviewed in the next chapter, add additional considerations to this empirical procedure.

Slight changes in the model can be made if one is dealing with a cash price and a futures price that address different forms of the product For example, one might be concerned with the cash price for fresh oranges and the futures price of orange concentrate as Ward-Dasse were. Here the basis would be defined as

$$(2.10) \quad B\{t\} = F\{t\} - (CP\{t\} + TC\{t\})$$

where

$CP\{t\}$ = cash price of the untransformed product,

$TC\{t\}$ = transformation costs.

By transforming the product presently, interest revenue is foregone, adding to the interest expense

$$(2.11) \quad M\{t\} = PS\{t\} + (CP\{t\} + TC\{t\})(\exp(rt) - 1).$$

The basis residual would be equal to $B\{t\} - M\{t\}$, using the above definitions.

Given these basis theories and resulting models, the empirical models ultimately become a relationship between the basis and stock variables, including proxy measures for some stock conditions. Most markets are dynamic and it is likely that the basis relationship changes over time due, in particular, to structural changes. Hence, in addition to having a theoretical framework for dealing with the problem, it is essential to have the econometric methods available to

deal with the dynamic modeling problems that are most likely embedded in the basis models. These methods are reviewed in the following section.

Parameter Variance in Regression Analysis

Classical ordinary least squares analysis assumes that the true population parameters do not change from observation to observation. Often it is more accurate to allow parameters to change or vary from observation period to observation period.

Causes of Parameter Changes

Evidence of structural changes, not having clear guidelines as to the models specification, and dealing with aggregated data all point toward the possibility that the constant parameter assumption of classical ordinary least squares may not be appropriate.

A structural change by definition implies a change in the impact of the explanatory variables. If it is possible to identify the time of the change, then it is often possible to base estimates only on data generated after this point. However, often not enough data are available or multiple changes have occurred over time. It is also possible that the response to the structural change is not fully realized at the point of the change, but rather the response evolves gradually, implying a continuous as opposed to a discrete change in parameters.

The assumptions employed by certain economic models may imply a structure that is continuously changing for their statistical counterparts. For example, if a variable or group of variables is assumed constant or placed under the *ceteris paribus* condition in reality change, then structural changes in the basic model may be implied. The modeler may be able to expand the scope of the model to incorporate the causes of these changes into the model. Too often the result is a large, cumbersome model. Often it is not possible or desirable to expand the model to allow for changing conditions.

Misspecifications can arise from various sources such as inappropriate functional forms, omission of explanatory variables, and the use of proxy variables. Aggregation can imply parameter variation over time if the micro variables change. Changes in the micro variables imply a change in the process generating the macro variables. (Ward and Meyers, 1979)

Models that Allow for Parameter Changes

Many econometric models have been formulated that allow for parameters to change. Switching regression models allow coefficients to be constant for a subset of observations but to differ across subsets. Included among these models are dummy variable models, seasonality models, and piecewise regression models (Judge, et al; 1980). This study is more concerned with models that allow for a parameter to change from observation to observation.

Most other variable parameter models can be classified as either stationary stochastic parameter models or nonstationary stochastic parameter models (Judge, et al; 1980). Stationary stochastic parameter models, such as the Hildreth-Houck random coefficient model, assume that the process generating the parameters is stationary. Parameters do not vary systematically across observations but vary randomly with a constant mean and variance. No constraints are placed on the means and variance of nonstationary stochastic parameter models, allowing for systematic changes in parameters over observations (one observation's parameter values influence the next observation's parameter values). Typically, they are used in time series analysis, while stationary stochastic parameter models are used in cross-sectional analysis to account for differences in micro units. Non-stationary parameter models are more relevant to the concerns of this study (Judge, et al; 1980).

Time varying parameter models are the least restrictive of the systematically varying parameter models. In many aspects, the Kalman filter models are the most general of this group. However, specification of Kalman filter models is often too difficult for economic problems (Judge, et al; 1980). The Cooley-Prescott model is the least restrictive with regard to the nature of the change traceable assuming the permanent component follows a moving average process and allows for systematic and/or non-systematic parameter

variations; parameters do not converge to any mean value. The Cooley-Prescott model is used for estimation in this study. Estimates using Kalman filters were also made but the results made little sense. Evidently more knowledge of the structure and interrelationships among parameters is needed for serious estimation using Kalman filters.

<u>The Cooley-Prescott Model</u>

Cooley and Prescott (1976) address a time series model.

(2.12) $\quad Y\{t\} = X\{t\}B\{t\}$

where X{t} is a 1 x (K + 1) vector of explanatory variables for period t, B{t} is a (K + 1) x 1 vector of parameters for period t, and Y{t} is a scaler representing the value of the dependent variable in period t. Both transitory and permanent errors affect the parameters of the model. Permanent errors are generated in a systematic pattern. These sources of variation on the B parameter vector are modeled as

(2.13) $\quad B\{t\} = B^*\{t\} + U\{t\}$

(2.14) $\quad B^*\{t\} = B^*\{t-1\} + V\{t\}$

where B*{t} is the permanent component, B{t} is the parameter indexing the permanent and transitory components, U{t} measures transitory error and V{t} errors associated with permanent change. It is assumed that U{t} and V{t} are identically and independently distributed normal variate variables, with zero mean vectors. It is possible to limit changes in parameters to particular variables, that is to

remove the permanent component for particular variables. If only the intercept is allowed to vary, the classical ordinary least squares model is implied, with the intercept varying to account for errors.

The covariance structure is

(2.15) $\quad Cov(U\{t\}) = (1 - \theta^*)\sigma^2 E\{u\}$, and

(2.16) $\quad Cov(V\{t\}) = \theta^*\sigma^2 E\{v\}$

where $E\{u\}$ and $E\{v\}$ are normalized matrices which are assumed known up to a scale factor. The relative magnitude of permanent and transitory change is reflected in θ^*, the index of permanent parameter adjustment; $1 - \theta^*$ measures the degree of transitory changes. If θ^* is large, close to one, most of the change in parameters from one period to the next will be reflected in subsequent periods' parameters. Thus, θ^* can be interpreted as a measure of the speed of parameter adjustment to structural changes. If θ^* equals zero, then the random coefficient model is implied and errors in one period will not influence parameters in subsequent periods. Judge, et al; (1980) review the rational behind the Cooley-Prescott estimation procedure.

Generally, the compositions of $E\{u\}$ and $E\{v\}$ are not known. Typically, they are assumed equal and based on the variance, co-variance matrix obtained by estimating the relationship using ordinary least squares. By setting the off-diagonal elements equal to zero, parameter changes for each independent variable are assumed to occur

independently. Several studies report the results to be robust with respect to changes in E{u} and E{v} (Cooley and Prescott, 1973; Hsiao, 1975; Ward and Meyers, 1979).

The model has many useful applications. It can be used to delineate structural shifts. By examining the variation of a particular parameter over time it is often possible to respecify the variable definition in a manner more representative of the phenomenon that it addresses. It is frequently used in forecasting, basing forecasts on the more recent parameter estimates. Problems such as serial correlation, multicollinearity, and heteroskedasticity are often removed by estimating the model using time-varying parameters (Ward and Meyers, 1979).

The Cooley-Prescott time varying parameter procedure is used in this study to investigate the possibility of changes in the impact of the determinants of the FCOJ basis over time. The Ward-Dasse model reviewed in the next chapter encompasses the relevant theoretical and empirical dimensions of FCOJ basis movements. In this study the Ward-Dasse model is estimated over a longer data period using ordinary least squares and modified slightly to allow for estimation using time varying parameter procedures.

CHAPTER III

REVIEW OF THE WARD-DASSE MODEL

The Ward-Dasse model of the FCCJ basis for the July contract delineates weekly determinates of basis patterns for the period beginning December 1967 and ending July 1974. Their model is the primary motivation behind the empirical models investigated in this study. It is chosen for extension and reformulation later in this study because it clearly identifies the primary determinates of FCCJ basis patterns.

Contributions of the Ward-Dasse Model

The Ward-Dasse model is not only noteworthy for the understanding it provides of the FCCJ futures market but also for the implications that its orientation has for studying futures markets in general. It is instructive in its emphasis on the significance of anticipatory and industry specific phenomena that may influence basis patterns. Previous to their study, empirical models of basis patterns were based only on the fundamental relationships encompassed by traditional storage theory. Failure to account for all phenomena that influence basis

patterns can lead to a distortion of empirical results since such a failure is, if significant, a form of specification error. Their model is also seminal in its allowing for consideration of the basis of a particular contract from the time the contract is opened until the maturation date in defining dependent variable. Most, if not all, previously reported studies had employed as the dependent variable the basis from a contract that was a particular fixed time from maturity (such as the nearby futures). For example, in a two month from maturity model, the basis from the contract terminating in April would be employed during the February observation period, while the June basis would be employed in April. Defining the dependent variable in this manner does not allow for the dynamic consideration of the basis pattern of a particular futures contract across its active period. Such dynamic consideration using fixed time from maturity models would necessitate the estimation of several models, each representing a different time from maturity. In this study both the fixed, or constant, contract approach and the fixed, or constant, period from maturity approach are used.

To allow for dynamic consideration of a specific contract Ward-Dasse select the July contract basis residual (defined as the July basis minus physical storage costs and implied interest expenses) as the dependent variable and define explanatory variables so that their value or

magnitude is influenced by the current time of year, thus allowing for their impact on the basis residual to be dependent on the time of the year. (Though the basis residual is the dependent variable, such models are often called basis models.) In other words, certain explanatory variables whose impact on the basis will vary during certain periods of the year are defined so that their magnitude is dependent on the time of the year. This dependence is achieved by weighting the remainder of the variable specifications by a function that is based on time of the year.

Basis Patterns

Before reviewing the model specification it is useful to review basis patterns for FCOJ so that an understanding can be reached as to what the model attempts to explain. Figure 3.1 shows mean basis residual values for the July FCOJ futures contract over the year (using a December 1967 to July 1974 period). Monthly basis residual values are presented in Chapter IV.

An attempt to portray a typical basis pattern for the July contract is presented in the upper portion of Figure 3.2. The plotting of this graph is somewhat arbitrary, though the general shape is representative of the pattern throughout the data period. The lower portion of the figure includes a review of key periods during the season. By simultaneous consideration of the graphs it is possible to

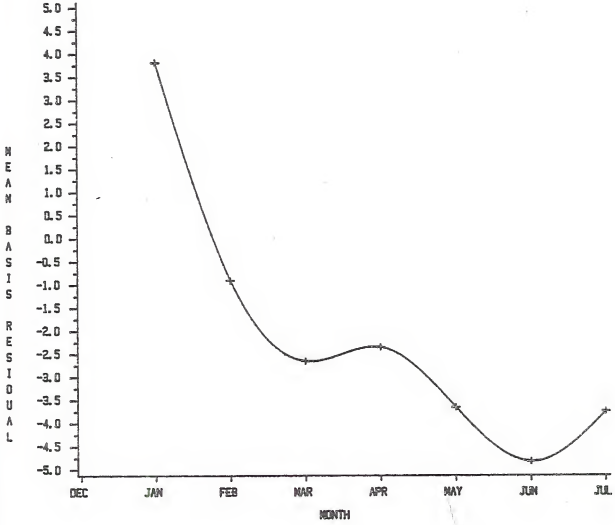

Figure 3.1. Mean July FCOJ basis residual values

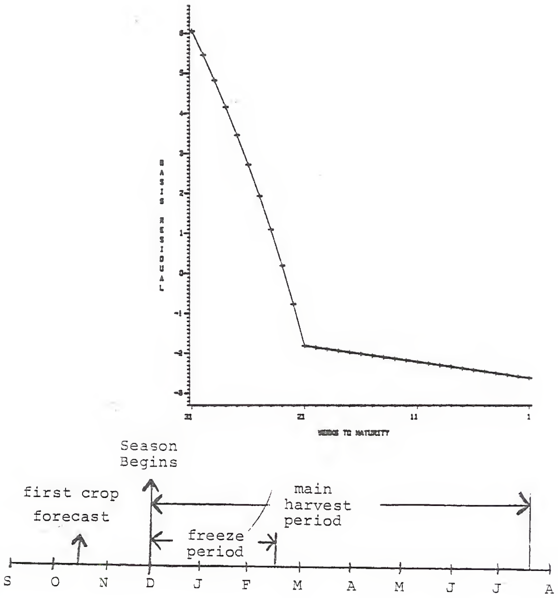

Figure 3.2. Typical FCOJ basis residual for the July contract and key periods during the year

review how basis patterns correspond to important industry events.

The upper graph extends from December through mid-July corresponding to the period covered by the Ward-Dasse model. The basis is largest during the potential freeze period of December through mid-February. It declines throughout winter and continues to decline after mid-February but at a slower rate. This general shape is due to several factors. The wider basis from December through winter reflects potential crop loss due to freeze and the corresponding freeze bias. As winter progresses the probability of having a freeze during the current season decreases due to the passage of time, hence the basis narrows. The passing of the freeze period marks the alleviation of most uncertainty regarding the season's final crop size. Prices for the remaining portion of the season are relatively easy to predict once the freeze period has passed. Price adjustments following a freeze are generally the largest. Price adjustments after the freeze period has passed tend to be relatively minor. The basis usually continues to decrease because risk and similar costs decrease as contract maturity approaches in July. If stocks are low, convenience yield considerations may result in a widening of the basis residual after winter.

Ward-Dasse selected the July contract rather than some other FCOJ futures contract because it extends over the main

harvest period, which runs from December to July, and yet it terminates far enough from the beginning of the next season (December) not to be greatly influenced by price adjustments associated with the next season's crop. Though the season begins on the first of December, the first official U.S. Department of Agriculture crop estimate is released in October which for the data period considered by Ward-Dasse was also the opening month of the July contract (currently contacts are active for more than a year). FOB price adjustments in the September-November period are common and often reflect expectations as to the next season's crop. By beginning the model in December the problem of dealing with interseasonal price adjustments is avoided. Also, for much of the data period considered by Ward-Dasse little trading on the July contract occurred prior to December which implies that liquidity problems probably existed, making measurement difficult. In this study constant period from maturity models are estimated using data throughout the year in order to investigate possible seasonal basis patterns not included in the December through July period considered by the Ward-Dasse model.

The Model Estimated

At this point a review of how the Ward-Dasse model was specified shall be presented. After the results are reported, an explanation is given as to how the variables that comprise the model interact to yield the general shape of the basis pattern shown in Figure 3.2.

<u>Model Specification</u>

The July contract basis residual is the dependent variable. It is defined as the current, July contract futures price minus the current cash price minus physical storage costs (including interest) necessary to carry one unit until the futures contract termination date. Since Ward-Dasse use the cash price of fresh fruit, the cost of transforming fruit to FCOJ is also included in their definition which follows:

(3.1) $B\{t\} = FP\{t\} - (CP\{t\} + TC\{t\})$

where

$B\{t\}$ = basis,

t = weeks from maturity (declines during season, starts at about 32, zero at maturity),

$FP\{t\}$ = futures price of bulk FCOJ for period t to mature in period t+k,

$CP\{t\}$ = raw fruit price as delivered into processors,

$TC\{t\}$ = cost of transforming raw fruit into bulk FCOJ.

(3.2) $M\{t\} = C\{t\} + (\exp(rt) - 1) (CP\{t\} + TC\{t\})$

where

$M\{t\}$ = total physical storage and interest costs,

t = weeks from maturity (declines during season),

$C\{t\}$ = physical storage costs for t periods,

r = weekly interest rate,

exp(rt) - 1 = an adjustment for calculating interest on the initial cash outlay,

(CP{t} and TC{t}) are defined above.

(3.3) BR{t} = B{t} - M{t}

where

BR{t} = basis residual,

other variables are defined above.

In the above definitions and throughout this study except where noted otherwise the (i) subscripts have been omitted from the variable notations. The subscript (i) would refer to the particular year in the data period that is addressed with (i) beginning at one and increasing over time. The subscript t is the weeks remaining in the current year until contract maturation where t decreases over the contract period each year and is zero at maturation. Considering t and (i) together would allow for identification of the date associated with a particular observation.

In defining the basis residual, costs that are used by theory to explain the size of the basis and which are easily and directly expressible in monetary terms are subtracted from the basis. These expenses are physical storage costs and implied interest costs. Theory states that the difference in the futures price and the cash price should reflect the physical cost of storage which is available for FCOJ and expressed in monetary terms. By obtaining fruit and converting it into FCOJ, processors are foregoing

interest revenue. Theoretically, the futures price should reflect this interest expense and thus it is subtracted from the basis.

Those factors not included in the basis residual definition are not readily expressible in monetary terms and thus their contribution to basis movements are not empirically obvious. The basis residual is regressed against other variables to allow for quantification on their impact on the basis.

The estimated relationship is presented below, followed by the details of the variable specifications. The signs within the parentheses denote the hypothesized direction of the influence of the explanatory variable on the basis residual. Variable specifications follow.

$$BR\{t\} = \theta\{0\} + \theta\{1\}RP\{t\} + \theta\{2\}CY\{t\} + \theta\{3\}ML\{t\} + \theta\{4\}FB\{t\} + \theta\{5\}FBA\{t\} + \theta\{6\}FZ\{t\} + \epsilon\{t\} \quad (3.4)$$

where

RP{T} = risk premium (+),

CY{t} = convenience yield (-),

ML{t} = market liquidity (no hypothesis),

FB{t} = freeze bias (+),

FBA{t} = freeze bias adjustment (-),

FZ{t} = freeze occurrence (+),

e{t} = error term.

Risk premium. The risk premium variable measures the tendency for the futures price to be bid up relative to the cash price due to the risk of unforeseen price changes. In order to induce the holding of stocks and bearing the risk of unforeseen price change, the anticipated price and the futures price should reflect a premium above the cash price. The risk premium as used in the Ward-Dasse model is an anticipatory phenomenon and the concept is operationalized as

(3.5) $RP\{t\} = (SA\{t\})(f\{t\})$

where

$SA\{t\}$ = season's availability or estimated availability of FCOJ from current season's crop (operationalized by the current crop forecast),

$f\{t\}$ = some function of time from maturity that declines as t approaches maturity and equals zero at contract termination.

The idea behind this definition is that the greater the expected availability of FCOJ for the season (or the expected new crop), then the greater is the potential for deviations in the actual crop from the expected crop and thus the greater the price risk. In other words, the more one expects, the greater the potential disappointment. One would expect price risks due to crop uncertainty to vary at different times within the season. As the Florida citrus season progresses, the remaining portion of the season's harvest remaining to be picked decreases. Correspondingly, risks associated with crop uncertainty, such as price risk,

tend to decrease. The $f(t)$ component of the risk premium definition adjusts the impact of $SA(t)$ on $RP(t)$ as suggested by time within the season. Since the December through July period covered by the model corresponds to the beginning of the season (in December) and the end of harvest (in July), $f(t)$ is defined as a decreasing function of time within the contract life that reaches zero during the contract termination period.

This period also corresponds to the portion of the July contract life considered in the model. Thus, $f(t)$ serves to decrease the impact of $SA(t)$ due to the contract approaching maturity and the season progressing.

This risk premium definition is somewhat different than that used for many empirical studies, where risk premium is a function of current stocks. The difference in treatment can be attributed to the importance of season ending inventories and uncertainties associated with the crop expectation. Prices are set by processors with a goal of attaining a certain carryover at the end of the season. If the expected size of the crop should change, prices will tend to change to meet carryover objectives.

<u>Convenience yield</u>. Convenience yield allows for the tendency of processors to value each unit of stock more when inventories are relatively low. To draw inventories below certain levels, processors expect a return in order to cover this additional value for doing so. The implication of low

inventories is an increase in the cash price and a lowering of the basis, *ceteris paribus*. The concept is operationalized as

$$
(3.6)\quad CY\{t\} = \begin{cases} ((1/S\{t\}) - 1)(f\{t\}), & \text{if } 0 < S\{t\} \le 1 \\ 0 & \text{, if } S\{t\} > 1 \end{cases}
$$

where

$S\{t\}$ = seasonally adjusted inventory level or $I\{t\}/MI\{t\}$, where $I\{t\}$ is actual inventory and $MI\{t\}$ is the normal level of inventories for the current period of the year,

$f\{t\}$ = some function of time from maturity which declines as t approaches maturity and is zero at contract termination.

Note that when stocks are relatively high, there is no convenience yield. When stocks are low, depleting inventories increases the convenience yield.

Market liquidity. Market liquidity addresses the possibility of futures price distortions arising from a sparsity of speculators relative to hedgers. Various definitions of liquidity occur in the literature. Ward-Dasse define ML as

$$
\begin{aligned}
(3.7)\quad ML\{t\} &= V\{t\}/|CHOI\{t\}| &&\text{, if } |CHOI\{t\}| \ge 1 \\
&= V\{t\} &&\text{, if } |CHOI\{t\}| = 0
\end{aligned}
$$

where

$V\{t\}$ = volume of futures trading,

$|CHOI\{t\}|$ = absolute value of the change in open interest from the previous to the current period.

The definition is motivated by the belief that volume of trading must exceed net change in open interest by a substantial amount to assure an unbiased price. Relatively low volume suggests that speculative interests may not be using the market to the extent necessary to offset the use of hedging concerns which are represented by the net change in open interest. A low value of MI{t} implies that liquidity problems may exist since speculative interests may not be balancing the actions of hedging interests.

The variables FP{t}, CY{t}, and MI{t} correspond to the traditional variables used in basis equations. The remaining variables in the model are specific to the FCOJ industry.

Freeze bias. The variables FB{t} and FBA{t} jointly delineate the tendency for the basis to be bid up during the freeze period by speculative interests hoping to profit from price increases due to freezes. The freeze bias (FB{t}) is defined so that it is highest during the beginning of the freeze period in December, which is also the first period considered each season by the model, and declines until it reaches and remains at zero once the potential for a freeze has passed. As time passes and thus the amount of time remaining in the season for a potential freeze to happen decreases, FB{t} and FBA{t} decrease. The FB{t} component is defined as

(3.8) $FB\{t\} = \ln(((t - t^*)/(maxt - t^*)) + 1)$, if $t > t^*$

$= 0$, if $t < t^*$

where

t = weeks remaining in contract life,

maxt = maximum value of t during the data period (equals 32),

t* = the value of t that corresponds to that period when the freeze bias no longer reacts to the threat of freezes (the results suggest a value of t=21 which corresponds to mid-February).

The freeze bias adjustment (FBA{t}) allows the projected availability of stocks for the season to influence the extent of the bias. Ward-Dasse hypothesize that greater stocks will result in less of a bias, <u>ceteris paribus</u>. FBA{t} is defined as

(3.9) FBA{t} = (FB{t})(NSA{t})

where

FB{t} = freeze bias as defined above,

NSA{t} = relative expected season's availability of FCOJ or SA{t} / MSA{t}, where SA{t} is the current expected season's availability as defined earlier and MSA{t} is the mean value of SA{t} for the data period during the current week of the season.

<u>Freeze occurrence</u>. The occurrence of an actual freeze is represented by FZ{t} which measures the tendency for the futures market price to react quicker than the orange cash market to the impact of a freeze. Following a freeze the basis tends to be larger until the cash market has completed its adjustment. The definition is

(3.10) FZ{t} = TEMP{t}

where

TEMP{t} = degrees below 28 , zero otherwise (temperature used is an average based on several different growing locations).

Estimation and Results

Due to the unknown value of t* (equations 3.8 and 3.9) Ward-Dasse estimated the model using a maximum likelihood procedure to select the value of t* that minimizes the sum of the squared errors. The estimated value of t* was 21 which corresponds to mid-February. The model was estimated as specified above and also with allowances for first order serial correlation. Since the data are discontinuous, that is there are no observations from the termination date in July to the opening date in December, standard procedures for correcting for serial correlation are not valid. The authors devised their own technique for dealing with the problem.

All estimated relationships were as originally hypothesized by the authors. Their results, reproduced in Table 3.1, did not confirm the significance of RP{t} and ML{t} for explaining FCOJ basis patterns. Various definitions were considered for f{t}; f{t} = t was adapted. Ward-Dasse interpreted the negative constant term as reflecting difference in quality between deliverable FCOJ and FCOJ typically used in commercial channels. Delivery costs are negligible due to the concentration of users in Florida and since all delivery points are in Florida. At maturity the basis residual tends to be negative.

Table 3.1. The Ward-Dasse model results

Constant	Risk Premium	Convenience Yield	Market Liquity	Freeze Bias FB{t}	Freeze Bias FBA{t}	Freeze
Maximum likelihood results:[1]						
-2.66	.0003022	-.29	.00454	36.71	-25.16	1.55
(4.93)[2]	(1.26)	(-4.14)	(0.083)	(7.18)	(-4.74)	(7.06)
other statistics: R^2=0.58 d=.52						
Corrected for serial correlation:						
-0.71	.0001265	-.21	-.00302	32.59	-21.4	1.10
(-2.58)	(0.34)	(-1.91)	(-0.96)	(4.15)	(-2.61)	(5.21)
other statistics: R^2=0.35 d=1.58						

[1] Maximum likelihood estimate of t* is 21. All results reported in terms of the units employed in the current study.
[2] t statistics are in parenthesis.

Impact of Explanatory Variables Over Time

To fully understand the model it is important to appreciate how the explanatory variables interact to allow for the basis pattern to be depicted dynamically throughout the season.

Variables FB{t}, FBA{t}, CY{t}, RP{t} and the constant term provide the basic shape of the pattern as shown in Figure 3.3. The lower graph which portrays the basis residual over time is produced by summing the other curves together. To allow for CY{t} and RP{t} to be represented over time, the CY{t} curve holds relative inventories constant and below the normal level and the RP{t} graph holds season's availability constant (in reality these variables do not tend to fluctuate significantly in the course of one season unless a freeze occurs). If inventories are above normal, then CY{t} has no effect on the basis residual. Parameters for FB{t} and FBA{t} measure the total freeze bias. FB{t} follows the same path each year since it is only a function of t. Basically, FBA{t} will act to shift the total affect of FB{t} on the basis residual as dictated by the expected season's availability. Increased expected availability increases FBA{t} and lessens the total freeze bias, decreasing the basis. The values of the variables over the data period insure that the total freeze bias will be positive as depicted. In essence, the magnitude of relative stocks, acting through CY{t}, and

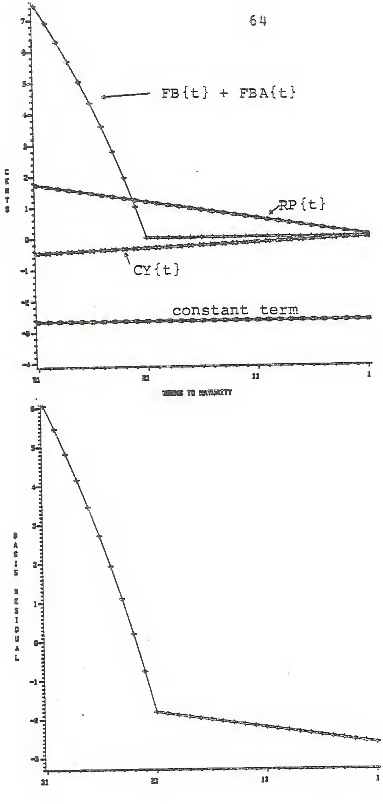

Figure 3.3. Interaction of explanatory variables in determining the July basis residual

season availability, acting through RP{t}, determine if the basis residual narrows or widens after the freeze bias period. In Figure 3.3 the widening influence of CY{t} is offset by the narrowing influence of RP{t} with the result being that the depicted basis residual is flat once the freeze bias period is passed or where t<21.

The impacts of FZ{t} and MI{t} are not included in the Figure 3.3. They are not functions of t. If a freeze occurs, there will be a large temporary jump in the basis. The basis will soon return to a more normal level; however, changes in the magnitudes of expected season's availability and inventories can be expected, which will tend to cause the basis pattern to deviate somewhat from its more normal form. Regardless of the events of the season, the basis residual will approach the value of the constant term at maturity unless major liquidity problems are present.

There have been many developments in the industry since Ward-Dasse specified and estimated their model. In the following chapter, Chapter IV, a review of prices and basis residual movements is presented to illustrate these changes. This review covers the period considered by the Ward-Dasse estimate and subsequent periods. Chapter V includes a review of the potential impact of recent industry developments, especially imports, on the FCOJ futures market and the implications these developments might have on the results of the Ward-Dasse model. Documentation of any

change in basis patterns would be useful to hedgers in developing strategies. Updated estimates are reviewed in Chapter VI. In Chapter VII estimates are presented using basis residual definitions based on fixed time away from maturity models. In Chapter V discussions are also included that provide for a richer understanding of certain aspects of the Ward-Dasse model and the rationale behind it that are not discussed in the current chapter.

CHAPTER IV

REVIEW OF BASIS RESIDUAL MOVEMENTS

In this chapter various orange industry price series and corresponding basis residual patterns are reviewed. Review of residual patterns does not point toward obvious basis changes over time. Clearly additional analysis, presented later in this study, is needed to document any possible change in patterns or the impact of basis residual determinants.

A history of the July contract basis residual movements is presented in Figure 4.1. Graphed are the basis residual values for the months of December through July each season. The period covered runs from December 1967 through June 1982 (there was no fruit spot price reported in July 1982 and thus no basis residual value for this month is reported in this chapter). This time period corresponds to that used to estimate an updated Ward-Dasse model in Chapter VI and encompasses the data period used by Ward-Dasse. The basis residual definition used is a monthly average of the weekly July basis residual definition included in Chapter VI. A monthly residual is reviewed here rather than a weekly version to allow for easier inspection of residual movements overtime.

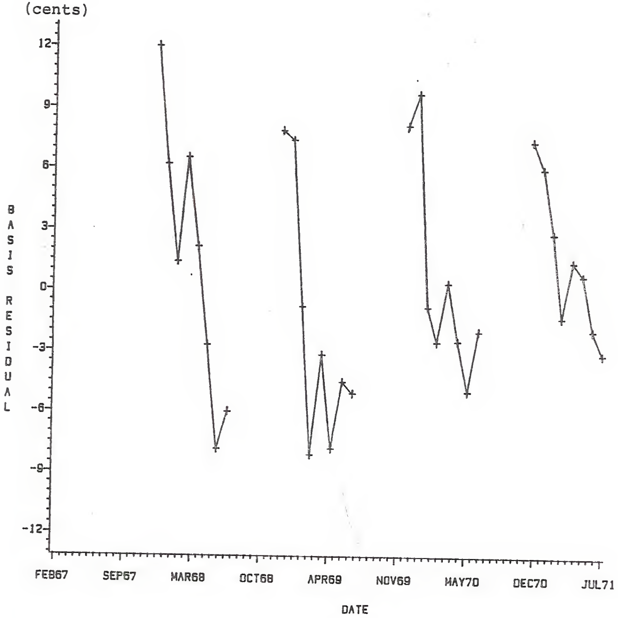

Figure 4.1. July FCOJ basis residual movements

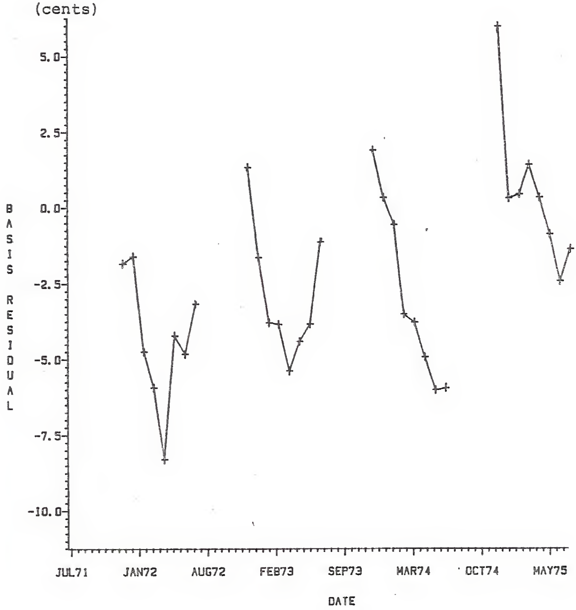

Figure 4.1--continued

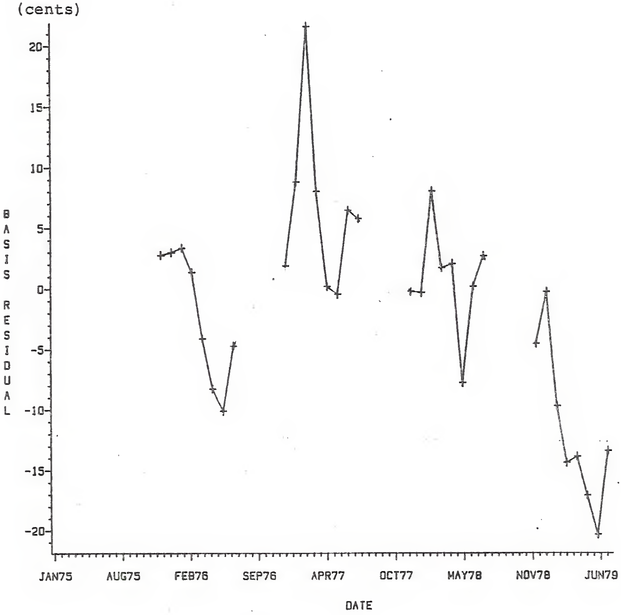

Figure 4.1--continued

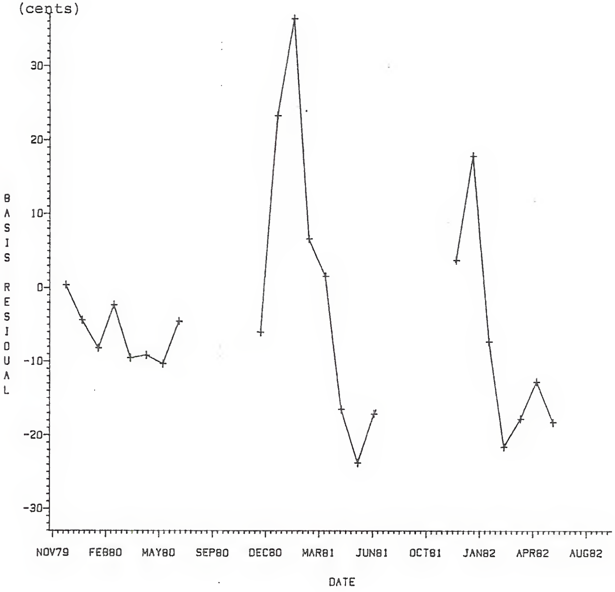

Figure 4.1--continued

Following Ward-Dasse, the July basis residual is defined as the current July futures price minus the current spot price of oranges minus costs associated with converting fruit into bulk FCOJ (an implied interest expense is also accounted for). Thus, it is a derived basis residual. Unlike the definition used by Ward-Dasse, it is reported in terms of cents per pound solids.

Review of July contract basis residual movements does not reveal any obvious changes overtime. A major goal of the estimation procedures used in this study is to identify any changes overtime in the impact of determinants of the basis residual.

A weekly July basis residual variable is used to re-estimate and update the Ward-Dasse model in Chapter VI using ordinary least squares. Unfortunately, the July basis residual variable is not suited for estimation using time varying parameters due to the discontinuity associated with switching contracts after contract maturity.

An alternative definition, which is used in estimating the time varying parameter models in Chapter VII, is to define the basis residual based on a constant or fixed time from maturity. Such definitions employ the futures price of the contract that is closest to being the specified period from maturity in defining the basis residual.

Three constant period from maturity data series, each based on a different cash or spot price, are reviewed in

Figure 4.2. The corresponding fruit spot price equivalents are reviewed in Figure 4.3.

Reviewed (in Figure 4.2) are four month from maturity basis residual variables defined based on three price series: the spot price of fruit, the wholesale FOB price, and the bulk FOB price. The wholesale FOB price is the price that Florida processors charge for retail sized FCOJ. The bulk FOB price is the price Florida processors charge for bulk concentrate similar to that sold on the FCOJ futures market. In defining the wholesale FOB and bulk FOB four month from maturity basis residual variables all processing and related costs are subtracted from the reported values to yield the derived spot price (these derived spot prices are reviewed in Figure 4.3 along with the actual spot price). The basis residual variables (Figure 4.2) are defined as the current futures price which is closest to being four months away from maturity minus the corresponding derived or actual spot price and costs associated with converting fruit into bulk and storage costs (implied interest expenses are also subtracted from the futures price). The same principle and similar processing data to that used in constructing Figure 4.1 are used in defining the four month from maturity basis residuals. The major differences is that interest and storage costs are always for a four month period. The variables values reported here are monthly averages of a weekly variable

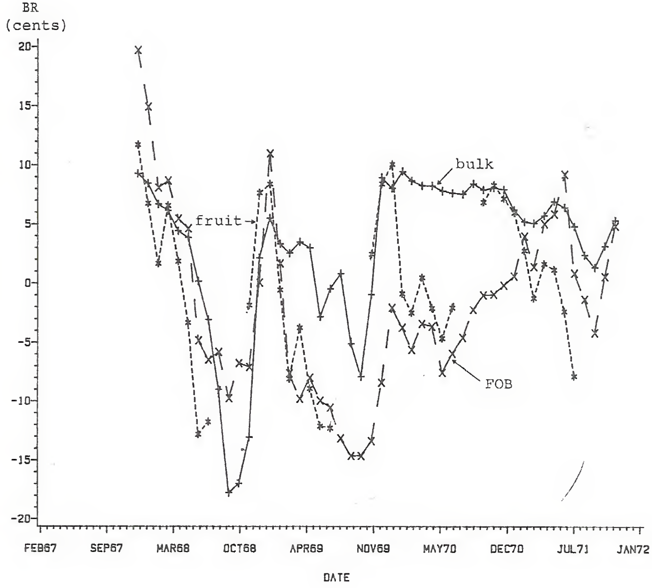

Figure 4.2. Four month from maturity basis residual movements based on various cash prices

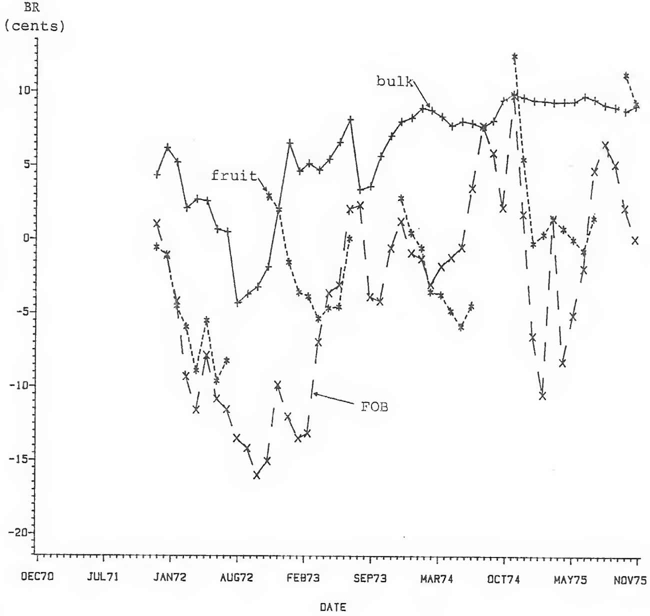

Figure 4.2--continued

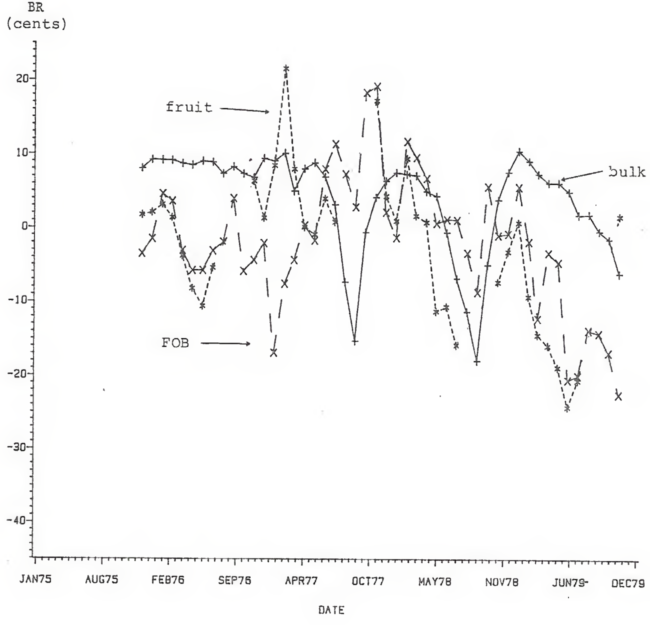

Figure 4.2--continued

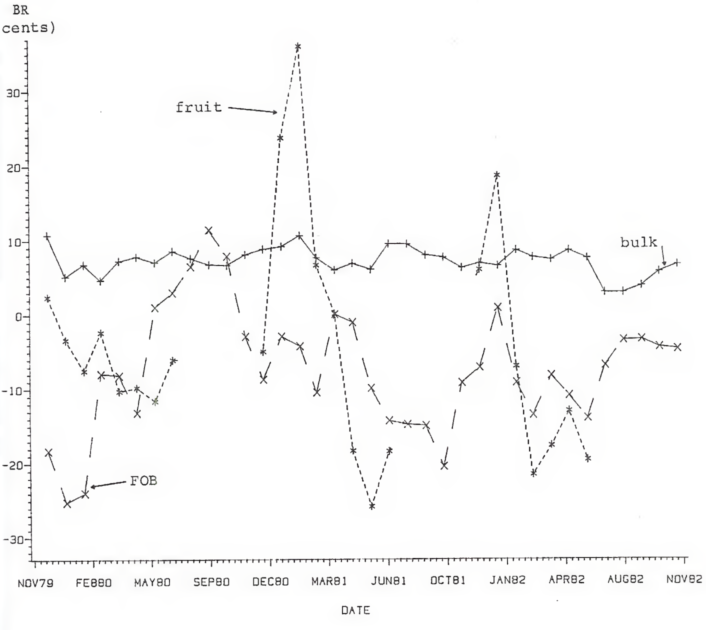

Figure 4.2--continued

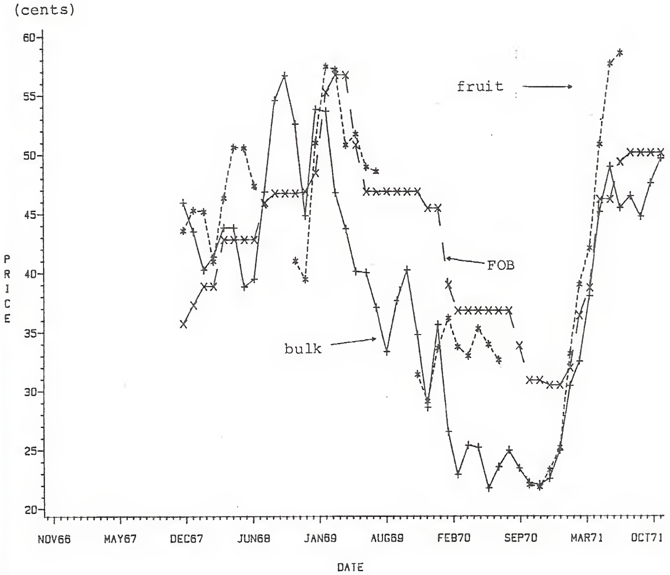

Figure 4.3. Various orange industry price movements

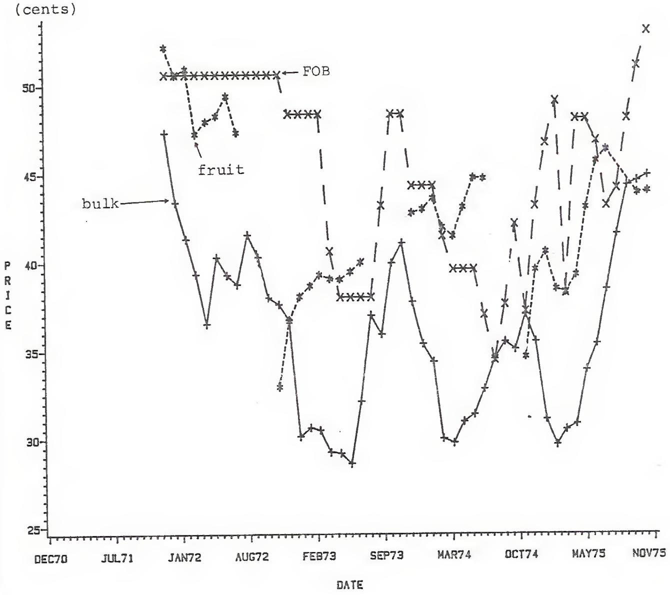

Figure 4.3--continued

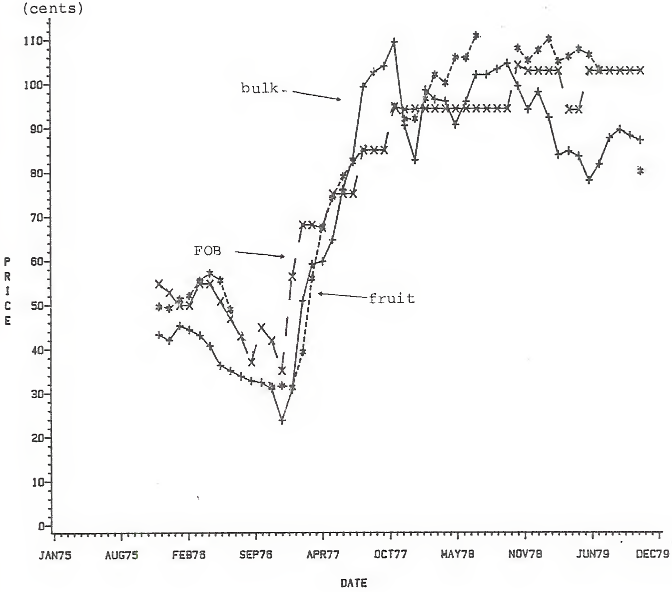

Figure 4.3--continued

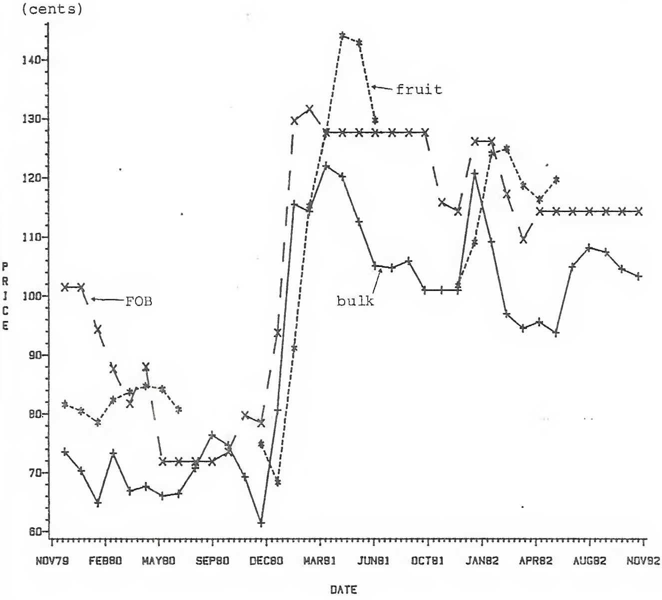

Figure 4.3--continued

(additional explanation of these definitions is presented in Chapters VII and VIII).

The wholesale FOB price usually changes only a few times each year and may remain unchanged for periods exceeding one year. The price used here is a card price or a quoted price. Actually, processors may give discounts to certain customers. Different processors usually charge the same FOB price for unadvertised FCOJ. Price leadership is generally used to coordinate changes in the card price.

The FOB bulk price varies among processors. The price used here is an average price. The FOB bulk price is not as rigid as the wholesale FOB price and thus is more apt to reflect current conditions. Processors occasionally discount bulk in order to sell excess inventories while not changing the wholesale FOB price.

Review of the derived spot prices and the actual fruit spot price, Figure 4.3, shows that prices have generally tended to increase overtime. Generally, the prices do move together but clearly there have been exceptions. The FOB price of bulk tends to be the lowest, reflecting perhaps its lower range in quality. The bulk FOB price used corresponds in quality to futures specifications. The other prices are for a higher quality product.

Almost all fruit in Florida is harvested between November and July. No spot fruit price is reported for the other months. Thus, there is no spot price reported for the

months of August, September, and October in Figure 4.2 and no spot price basis residual reported in Figure 4.3 for these months.

The four month from maturity basis residual patterns, Figure 4.2, do not exhibit any noticeable trend overtime. There are no obvious changes overtime in the corresponding six, five, three, and two month from maturity basis residual variables. Note that no residual is reported for the spot fruit price basis residual variable in August, September, and October since a spot market does not exist during these months.

Estimating a time varying parameter model using a basis residual variable based on the spot fruit price would require some alternative definition during the August through October period. Possible alternatives are discussed in Chapter VII.

In conclusion, inspection of FCOJ basis residual movements reveals no obvious trend or change in the residual overtime. However, it is possible that the impact of the determinants of the basis residual has changed. A change in the impact of important factors such as inventories, the crop forecast, and the freeze bias would imply a change in basis residual patterns. In the next chapter changes in the industry that may have influenced basis residual patterns are discussed.

CHAPTER V

THEORETICAL ADJUSTMENTS TO THE FCOJ BASIS

A major concern of this study, elaborated in Chapter I, can be summarized as quantifying any changes in FCOJ basis patterns that have developed in recent years. General theoretical interpretations of recent industrial trends and developments are presented in this chapter to point towards why one might expect efficient futures pricing to have led to a change in basis patterns. Next, storage theory is used to provide a theoretical framework to focus on potential basis adjustments. Such a focus aids in simplifying and directing the analysis and is necessary to facilitate the empirical analyses.

General Analysis

Increased importing of frozen concentrated orange juice has coincided with a general increase in the quality and availability of foreign concentrate. Ten years ago imported FCOJ was generally inferior to most U.S. concentrate. Changes in growing, processing, and transportation practices in Brazil since the early 1970's have resulted in a general increase in the quality of Brazilian FCOJ available for exporting to the U.S. and other foreign markets.

Arguments can now be made that the value (as contrasted to actual prices) of imports is essentially the same as domestic juice (value and usefulness are often dependent on the eventual use of the juice and the relative availability of different quality juices which are typically blended). When the futures market for FCOJ was organized, contract specifications were drawn based only on consideration of domestic markets. Initially futures commitments were essentially fulfilled with domestic juice. Increased importing, improvements in import quality, and the broad futures contract definition of acceptable juice have resulted in both domestic and foreign juice of acceptable quality being usable to meet contract commitments. The futures price can no longer be viewed as the expected future price of Florida FCOJ but rather as some weighting of the value of Florida FCOJ and imported FCOJ expected for subsequent periods.

Such circumstances should result in an increased level of uncertainty for futures traders. Increased uncertainty should affect the usefulness of the market for some potential users and may lead to a change in the practices and composition of actual traders. Obviously, one who buys forward with the intent of actually taking delivery is less certain about the type of juice that will be received.

Perhaps the most significant impact of imports for the FCOJ futures market is their tendency to provide an

alternative for dealing with unforeseen circumstances such as crop loss due to a freeze. Imports provide processors an alternative source of supply and thus can mitigate increased fruit prices following a freeze.

Using imports to substitute for domestic juice given a freeze represents a fundamental change in the industry. Historically inventory management has been a key factor in pricing decisions by processors, reflecting the use of inventories to cope with uncertainties associated with crop losses due to freezes. Basically, prices have been set with the goal of having a season ending carryover that is usually in the range of 11 to 15 weeks of equivalent supplies. The actual level of carryover has tended to vary with supply and price conditions. Low supplies and high prices have tended to result in slightly less carryover, with some sales for these years coming from a decreased inventory level (sales being greater than harvest plus net imports). The effect of such policies appears to result in a stabilization of prices over time as prices are held down in freeze years. Generally, stable prices and the avoidance of large price increases are viewed by the industry as desirable. Large price increases in the past have been thought to be connected to the introduction of substitute products. It has also been feared that increased consumer use of substitute products due to high prices might result in changes in tastes and preferences, thus resulting in a permanent

switching away from orange juices. Most research studies have not supported this argument, however.

If one assumes that demand is fixed from year to year and that supplies vary from year to year about some known average value, then one can conceptualize the historical pricing-inventory policy discussed above as an attempt to price such that the quantity sold each year equals the average crop size. Departures from this orientation in reality can be attributed to lack of perfect knowledge and foresight and attitudes towards risk.

The increased availability of imports suggests that the historical pricing-inventory policy can no longer adequately describe the motivation behind pricing and inventory decisions. Processors now face less of a constraint in the quantity they can sell. The price of imports and the sensitivity of this price to increases in demand are now of key importance. It is essential to now conceptualize domestic pricing and importing as occurring simultaneously. According to this conceptualization, importing will occur if available domestic supply suggests a domestic price that is greater than the price of imports plus tariffs. Import prices due to increased importing may rise and in essence serve as marginal cost for the processors. The level of imports will depend on the degree of competitiveness in the industry. Competitive pricing should result in the import and domestic price differing only by a tariff level,

importing costs, and allowance for any quality differences. The monopoly solution will result in importing and pricing decisions being based on the intersection of marginal cost with marginal revenue for the monopolistic firm. Other possible importing and pricing decisions would be between these two extremes.

Drawbacks of such a conceptualization include the fact that it is static and does not come to terms with uncertainty and the concern for profits over time. Imports and sales are continuous occurrences. Current imports may be high relative to the levels suggested by analysis based on marginal cost. For example, the price of imports may be perceived as cheap relative to prices that are anticipated for the future. Decisions may be made to add to inventories and forgo present profit maximization in order to have relatively cheap supplies available in the future. Use of contracts and time associated with the importing add additional complications. Previously imports had very little to do with domestic prices and sales when imports were low. Significant levels of imports were not possible because they were not available. Theoretically, relatively small changes in the quantity of imports demanded would result in either a relatively large increase in the price of imports or an exhaustion of exporters' supplies. Large price adjustments were not common. Large jumps in the level of imports did not occur.

The growth of U.S. imports and their potential as a substitute for domestic juice denote a change in the domestic pricing-inventory policy. This is not to say that inventories and their role as a hedge against freezes are no longer important. In addition to providing protection from supply losses due to freezes, inventories now can also serve to protect from increases in the price of imports. Understanding of domestic prices can no longer be based on mere consideration of the domestic demand, supply, and inventory situation but must also include foreign production. Also, the potential now exists for more extreme domestic price increases in response to an interruption of imports.

While increased importing due to increased availability connotes a decrease in domestic prices *ceteris paribus*, to conclude that increased importing has led to decreased domestic prices is not necessarily correct. Coinciding with and a determinant of increased imports has been a shifting to the right in the demand for FCOJ. This shifting reflects many factors, including the effects of advertising and development of the chilled orange juice market. The trend has been towards increased prices.

Also coinciding with increased imports has been the establishment of non-Florida processors. These processors often reconstitute imported FCOJ into COJ and other juices. This change represents a potential additional source of

competition to Florida processors. Changes in competition will affect the relationship between marginal costs and prices received in an oligopolistic industry. According to this view, if there has been no impact on profitability defined in terms of the difference in marginal cost and price, there has been no effect on competitiveness. Increased competition implies a lowering of price, *ceteris paribus* (if major economies of scale associated with increased production are not present). Competitive modeling also views firm entry as leading to increased competition if the aggregate supply curve is shifted so as to lower the price. If the entry of non-Florida firms has not affected competitiveness, which appears unlikely, then their importing and selling function would probably have been executed by existing Florida firms. It is more likely that these firms have caused increased importing and a lowering of domestic prices, *ceteris paribus*.

In understanding the significance of the COJ market expansion, it is important to recognize that bulk FCOJ is used in COJ production and that both products merely represent different uses of oranges. For our purpose here it is most convenient to treat the two markets together and to conceptualize a demand for bulk FCOJ at the point before it is converted into COJ. The tendency for all industry prices to move together leads to the interpretation that they respond to the same basic, underlying causes and that aggregation is appropriate.

The impact of the phenomena of increased importing, establishment of out of Florida processing, and development of the COJ market on the FCOJ futures market can ultimately be traced to supply and demand considerations. Market participants guided by their own best interests will tend to create pressure that will result in supply and demand adjustments so that efficient pricing occurs. The complexity of these changes suggests that time might be necessary for participants to fully understand the ramifications of these changes for their own interests and for permanent versus transitory changes in supply and demand to occur. Limitations on traders are not the only reason to suspect the existence of an adjustment period. Even if exhaustive economic analyses were to be made available to all concerned, complete understanding seems unlikely since the conclusiveness or usefulness of such analyses would be a function of the availability of information and data. Data are needed when the implications of theory are ambiguous and to assess the magnitude and significance of non-ambiguous hypotheses. Availability of data is, of course, contingent on time passing since the situation changed.

Changes in supply and demand of futures commitments are ultimately traceable to the usefulness of the market to the participants in the industry. In that increased importing is now an option to rationing supplies via price increases, one can argue that there is less price risk or price

uncertainty presently which is a major motive for futures trading. However, if one considers the possibility of import interruption, which has not been a problem in the past, then less assurance exists as to the degree of price risk or uncertainty. Though traders may feel more confident as to the range of potential future prices, many additional factors are present today that may influence the eventual price. Previously, predicting prices given that a freeze would not occur was relatively easier than today. Today price risks come from more sources.

It appears that Florida processors have generally lost a degree of certainty as to future conditions which should increase the usefulness of the futures market for them. Time associated with the execution of importing contracts also provides processors additional reason to use the futures market. Import contracting is a form of forward contracting where a fixed price and quantity are agreed upon for delivery in the future. By selling futures forward at the time of the import agreement, importers can, to a degree, insure protection from the risk that prices may fall in the interim. A change in the form of inventory holdings, towards increased tank holdings and less holdings in the smaller 55 gallon bulk containers, may have decreased processors willingness to make deliveries on futures contracts.

The potential effect on growers is largely due to changes in pricing and the associated risks mentioned above. Those who market their fruit through cooperatives and participation plans face less price risk because their return is a function of FCB prices across the season and not only current prices. Those who sell in the cash market face greater price risk and will tend to be more sensitive to changes in price risk.

Attitudes about risk being a major attribute employed by theory to explain speculative behavior would lead one to suspect a change in the speculative interests that use the futures market. Continued use by many is likely because of their accumulated knowledge about the industry. To the extent that particular traders understand the ramifications of industry developments, they will tend to gain at the expense of the less informed.

In summary, the overall effect of imports and coinciding events is a different environment which might well influence FCOJ futures trading, futures prices, and basis movements.

Storage Theory Analysis

It is desirable to treat the various concerns discussed in the previous section within one theoretical framework. Such treatment will hopefully provide a focus, allowing for clearer, less complex theoretical and empirical analyses.

Traditional storage theory being concerned with the basis only has many advantages when compared to supply and demand type analysis and similar techniques which are designed to explain futures prices. The futures price is important. However, by dealing with the basis only, one avoids the complication of dealing with the general level of the FCOJ prices, which have consistently increased in the last several seasons. This increase is not of immediate concern for hedging or efficiency considerations, which are ultimately related to the temporal differences in prices over time. Successful hedging generally depends on whether the basis widens or narrows. Efficient futures pricing, like efficient allocation of a good over time, depends on whether price differences across time reflect the various costs associated with storage. By introducing the present or trend price level into the analysis, complexities are introduced that may prevent precise delineation of the basic concerns of hedging and efficiency.

For the FCOJ industry storage theory implies strong concern for the actions of processors, who provide the storage function for the industry. As discussed in Chapter I, Florida processors set FOB prices thus establishing product value throughout the industry. As a whole, processors are a relatively well informed group, a reflection of their position in the marketing chain which calls for dealing with most stages throughout the vertical

distribution system. Processors have played a direct role in the increase in imports, suggesting that as a whole they are in a position to best understand the implications of imports and associated developments for prices and future values. Processors also keep detailed data on their operations. These considerations suggest that an analysis based on storage theory for the FCOJ industry will be relatively free of distortions.

As reviewed in Chapter I, storage theory is applicable to conceptualizing basis patterns because both are concerned with differences in prices over time. Efficient, profitable storage activities imply that decisions as to the amount stored be based on the return to storage which is a function of future prices and storage costs. Since prices in the future cannot be known with certainty, storage decisions must often be based on an expected or probable future price. The profit motive reflected through arbitrage insures that the implied expected price that storage is based on is equivalent to the futures market price if efficient storage and futures pricing is present. For example, if present storage is being based on a price that is less than the futures price, such stored goods can be sold forward at the quoted futures price, thus locking in at least a minimum level of return. Processors can revise their plans and their expected price by selling forward and thus locking in the futures price.

Hypothesized Effect On the Ward-Dasse Model

The Ward-Dasse model (reviewed in Chapter III) which explains FCOJ basis movements through storage theory provides a sound framework for considering FCOJ basis movements. All concerns of classical storage theory are addressed by the model. However, developments in the industry imply that the estimated results may not be applicable today. Changes in the levels and ranges of the explanatory variables and differences in prices suggest that an estimate based on recent data would be more useful in accessing present circumstances than the original results. More important is the possibility that certain conditions have changed that are assumed constant or placed under the *ceteris paribus* condition in storage theory. Changes in such conditions could result in charges in the estimated parameters.

Increased importing might well represent a change in underlying conditions assumed constant by storage theory and the Ward-Dasse model. This is not to say that the exact level of imports is assumed to remain constant by their model. Rather it is assumed that the level of imports when the industry is faced with a certain set of conditions will be similar. Documentation of such a change is difficult. Imports have increased substantially and other economic conditions have changed, making it impossible to compare similar conditions.

In analyzing the impact of the noted industry developments, focus shall be placed next on how the estimated coefficients or parameters of the independent variables of the Ward-Dasse model might have changed since their original estimate. Their use of a basis residual variable formed by subtracting physical storage and interest costs from the basis as the dependent variable is still applicable. Defining the dependent variable in this manner in effect restricts the coefficients of these costs to equal one. Since theory suggests that in equilibrium competitive pricing results in price differences over time reflecting physical storage costs, the restriction is justified and should not change over time. By reducing the number of explanatory variables in this manner, the ability to measure the influence of the other explanatory variable is increased. Defining physical storage costs is relatively easy and straightforward. Operationalization of the other cost concepts is less straightforward and their definitions cannot be reduced to a monetary unit, thus preventing any additional restrictions.

<u>Convenience yield</u>. Convenience yield, reviewed in Chapter II, is described by Brennan (1958) as a motive for carrying stocks that allows one to be in a position to take advantage of an unexpected demand increase without revising production schedules. It prevents losses due to lost sales and operational inefficiencies associated with frequent

deliveries, processing, and revision of production schedules. Whether one wishes to conceptualize convenience yield as a way to avoid costs (a convenience motive) or a way to increase the probability of future profits (a speculative motive) is a difficult choice since it clearly addresses both concerns as noted by Brennan:

> When referring to the motives for holding money, the convenience motive is ordinarily distinguished from the speculative motive. The exact counterpart of this convenience motive for holding stocks would apply strictly only to those held in order to avoid the nuisance and cost of (1) frequent deliveries for processing and (2) frequent revisions of the production schedule to effect increased sales. The definition presented in this paper is somewhat broader. To include in the definition of convenience yield the benefit of being in a position to take advantage of a possible price rise on short notice would seem to place these holdings in the category of speculative stocks.
>
> In such questions of definition, usefulness is generally accepted as the criterion for choice. The line of distinction between convenience and speculative stock is a thin one. If a firm is presumed to hold stocks for the purpose of convenient handling of an expanded flow of orders, how can this increase in orders occur unless the total market demand for consumption increases? If it is not a mere shift in order from one firm to another while market demand remains unchanged, the current price can remain constant only if supply is perfectly elastic in the short run; there is nothing a priori to guarantee that this is the case. On the contrary, once stocks have been put into storage with the intention of carrying them to a future period, price in the current period would have to be bid up by those who intend to consume them in order that some of the stocks be diverted to current consumption. (1958,pp.70,71)

Increased availability of imports lessens the extent that domestic inventories must be relied on to meet sales in

the future. Previously, inventories at certain times of the year represented all available supplies. Imports provide an alternative source of supplies, lessening the degree that domestic inventories must be relied on to deal with unforeseen increases in demand. Less concern need be placed on present inventory levels. If inventories should fall too low, imports can be used to increase them to a more desirable level. Given a freeze, the return to inventories will be less with increased import availability. The speculative motive for holding inventories should have decreased.

Domestic fruit is processed when ripened. Processors have little control over the inflow of domestic oranges. The concepts of efficient production scheduling, control over deliveries, and operational efficiency are of minor importance in analyzing the domestic scene. These concepts are more applicable to the analysis of imports. Imports provide an additional source of supplies and allow for less concern over the scheduling or controlling of sales. The possible lost convenience of decreasing inventories presently is less if imports can eventually be used to increase inventories.

Thus, both the speculative and convenience motives appear to have decreased. It is hypothesized that the convenience yield coefficient has become less negative with the growth of foreign supplies.

Risk premium. The impact on the risk premium coefficient hinges on the implications of industry developments on the perceived degree of risk or uncertainty associated with future prices. The risk premium variable, discussed in Chapters II and III, is motivated by what Brennan (1958) calls the risk-aversion component of storage cost. Marginal risk-aversion is often viewed as an increasing function of inventories. As inventories rise, potential losses from unforeseen price changes increase. Brennan hypothesizes that for most instances one can expect a point to exist where additions to inventory will result in marginal risk increasing very rapidly since at this point additional potential losses from unforeseen price changes would seriously endanger the firm's financial standing. According to this view, both the expected price in the future and the futures price will tend to be higher at larger inventory levels.

The Ward-Dasse model operationalizes the risk premium concept with a crop forecast variable multiplied by a time component. The logic is that the larger the forecast, then the greater the possibility that future inventories will deviate from their expected level due to inaccurate forecasting, resulting in a revision of price expectations.

Arguments for both an increase and a decrease in the risk premium coefficient since Ward-Dasse's estimate can be cited. Though imports potentially can mitigate price

changes due to freezes, the possibility of import interruption increases the potential magnitude of price increases. Generally, Florida processors appear less certain as to future conditions and prices due to the increased reliance on imports and increased processing of orange juice outside the state of Florida. It is hypothesized that the risk premium coefficient has increased in recent years. Imports probably help hold down price increases following a freeze, suggesting less risk. However, increased import availability, a change in Brazilian pricing, or an increase in domestic competitiveness all imply greater price risk.

Market liquidity. No hypothesis is offered for market liquidity the other traditional explanatory variable, in addition to convenience yield and risk premium, in the Ward-Dasse model. Market liquidity addresses price distortions resulting from a lack of speculation relative to hedging activities in the futures market. Ward-Dasse found the market liquidity variable to be insignificant.

Freeze bias. Explanatory variables unique to the FCOJ market are freeze bias and freeze occurrence. Freeze bias addresses the tendency for the basis to be bid up by speculative traders who hope to profit from the occurrence of a freeze. The total freeze bias effect was measured by the use of two variables -- the freeze bias variable (FB{t})

and the freeze bias adjustment variable (FBA{t}) which allows for available supplies to influence the extent of the total freeze bias. See Chapter III for discussion of these variables.

Industry developments, especially importing, appear to have potentially lessened the affect of freezes on prices. It was hypothesized that the total freeze bias measured by the net impact of FB{t} and FBA{t} has decreased due to increased import availability.

Freeze occurrence. The freeze occurrence variable was included because the futures price tends to react quicker than the cash market to to actual freezes resulting in a temporary widening of the basis. It was hypothesized that the freeze occurrence variable coefficient has decreased due to the apparent mitigation of the effect of freezes on prices. That is, for the same level of stocks one would expect the market to reflect less of the potential impact from a freeze resulting in a potential crop shortfall since imports could be brought in to partially offset some of the crop losses.

Hypothesized Dynamics of Market Adjustments

In addressing the hypothesized change in the coefficients it is important to distinguish between a one time change and various possible adjustments that would occur over time. A one time change in coefficients implies

that all the cited changes that potentially affect the basis occurred at some identifiable, discrete point in time and that market participants fully understood these changes and reacted accordingly. If an adjustment period is needed for participants to understand changes, participants vary in the time it takes for them to react, and/or multiple changes occur, then a one time adjustment may not be plausible.

The nature and diversity of the cited developments in the FCOJ industry lend support to the interpretation that if some change in coefficients has occured, then most likely some adjustment period was needed. No discrete point in time can be isolated and labeled as the point at which the hypothesized structural shift occurred. It is most doubtful that market participants became aware of these changes immediately after their occurrence or fully understood the implications of such changes. Rather, it appears more likely that time was needed for understanding to occur and that different concerns varied in the time needed to gain awareness. The nature of the developments suggests possible structural changes have not taken place at a particular point or period in time but have occurred in a continuous manner over an extended period. For example, imports have trended upward during the last decade; hence the implication is for a continuous change in <u>ceteris paribus</u> conditions and continuous adjustments in the coefficients.

To conceptualize potential changes in coefficients as occurring in a continuous fashion over time appears to provide a framework that allows for adjustments in the coefficients to correspond reasonably well to changes in conditions and yet one that is not unnecessarily complex. Such an approach was employed in estimation. Figure 5.1 provides insight into the dynamics of the adjustment process implied by the time varying parameter procedure employed by using a change in import conditions as an example. Consider a level of imports that is relatively high, based on previous experience, for current conditions or circumstances. Initially or in the short run inventories or stocks will increase due to increased imports, _ceteris paribus_. Increased stocks will result in a change in the basis residual as determined by the current coefficients of the model (effect A in the diagram). If imports should continue at this higher level, then market participants will soon conclude that the increase in imports does not represent a random occurrence but a permanent change. They will come to expect higher levels of imports. This change in expectations should be manifested by parameter changes in the model (effect B in the diagram).

Changed parameters result in conditions similar to those in the past causing a different or changed basis prediction. Also, in the long run, the increased import level might well result in a change in the values of the

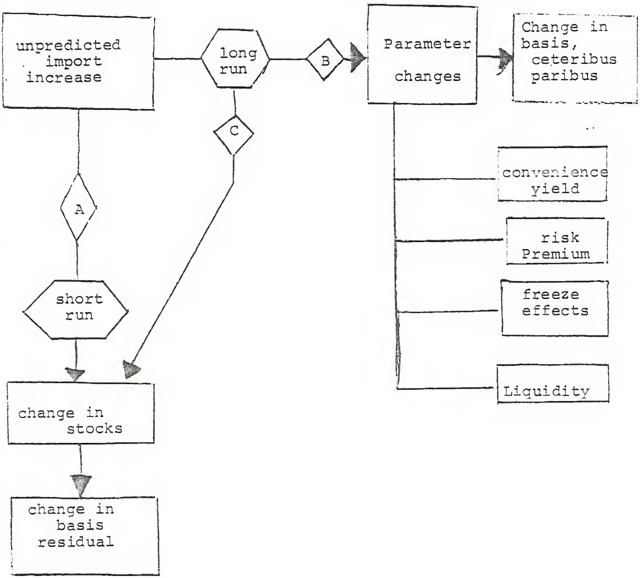

Figure 5.1. Hypothesized effect of unpredicted import increase on the model

dependent variables in the model, such as inventories (effect C in the diagram). Temporary increases in imports would not result in significant long run effects but would act mainly in the short run.

Adapting this perspective to the developments in the FCOJ industry and the trend nature of these developments results in the interpretation that parameters have changed, corresponding to the trend, while deviations from the trend have only resulted in temporary or short run changes. In essence, the implication is that market participants form expectations as suggested by the trend and these expectations influence basis patterns via parameter changes.

The exogenous or <u>ceteris paribus</u> variables values that deviate from the trend have their influence concentrated in the short run. (Exogenous is used in this study to refer to variables or conditions not embodied in the Ward-Dasse model. They are placed under <u>ceteris paribus</u> by their model.) The basis at any point in time is more a function of where the trend of exogenous conditions is at that time than the actual level of the exogenous conditions.

No relationship between independent variables and exogenous variables is necessary. For example, there does not appear to have been a noticeable change in inventories carried by processors, despite increased imports. Changes in the <u>ceteris paribus</u> condition will influence parameters even if these changes are not correlated with changes in the independent variables.

The mathematical implications of the proposed adjustments are presented below by way of comparison to the Ward-Dasse model. The original Ward-Dasse model is summarized as

(5.1) $BR\{t\} = f(\ RP\{t\},\ CY\{t\},\ ML\{t\},\ FB\{t\},\ FBA\{t\},\ FZ\{t\},\ |\ |X\{t\}|\ )$.

(5.2) given $|X\{t\}| = |X\{t-1\}|$

where

$BR\{t\}$ = basis residual,

$CY\{t\}$ = convenience yield,

$ML\{t\}$ = market liquidity,

$FB\{t\}$ = freeze bias,

$FBA\{t\}$ = freeze bias adjustment,

$FZ\{t\}$ = freeze occurence,

$|X\{t\}|$ = vector of exogenous conditions or variables.

Note that $|X\{t\}|$ is an attempt to quantify exogenous factors that are placed under the _ceteris paribus_ condition by the Ward-Dasse model. These factors are assumed to remain constant over time as is stated by equation 5.2 but may have changed significantly since the Ward-Dasse model was estimated. It should be noted that the vector $|X\{t\}|$ represents a rather abstract concept; actually, it would not be possible to quantify exogenous factors as accurately as $|X\{t\}|$ implies. The independent variables are defined as

(5.3) $RP\{t\} = f(\ SA\{t\},\ t\ )$,

$CY\{t\} = f(\ S\{t\},\ t\ )$,

$ML\{t\} = f(\ V\{t\},\ |CHCI|\ )$,

$$FB\{t\} = f(\ t,\ t^*\ )$$

$$FBA\{t\} = f(\ t,\ t^*,\ NSA\{t\}\ ) = f(\ FB\{t\},\ NSA\{t\}\ ),$$

$$FZ\{t\} = f(\ TEMP\{T\}\ )$$

where

$SA\{t\}$ = current prediction of stocks available for season,

t = time in the season (weeks remaining in the life of a specific contract),

$V\{t\}$ = volume of futures trading,

$|CHOI\{t\}|$ = absolute value of change in open interest

t^* = t when threat of freeze has past,

$NSA\{t\}$ = current predicted available stocks for season weighted by average predicted availability for the present time in the season,

$TEMP\{t\}$ = average degrees below 28 at selected growing regions.

Table 5.1 reviews coefficient relationships and hypothesizes for the Ward-Dasse model definitional relationships (time subscripts have been omitted).

Time or t in the Ward-Dasse model refers to time within the season or length of time from the termination of the July contract. The final week of the July contract has a t value of zero, regardless of the year considered. To incorporate the possibility of allowing parameters to vary across seasons, the concept of continuous time or cumulative time must be introduced. Towards this end, T is defined as the number of periods elapsed since the beginning of the data period under consideration; T begins with one and

Table 5.1. Review of relationships in the Ward-Dasse model

Predicted Parameter Relationship	Definitional Relationship	Chain Relationship
$\partial BR/\partial RP > 0$	$\partial RP/\partial SA > 0$	$(\partial BR/\partial RP)(\partial RP/\partial SA) > 0$
$\partial BR/\partial CY > 0$	$\partial CY/\partial S < 0$[1]	$(\partial BR/\partial CY)(\partial CY/\partial S) > 0$
$\partial BR/\partial ML \leq 0$	$\partial ML/\partial V > 0$	$(\partial BR/\partial ML)(\partial ML/\partial V) \leq 0$
	$\partial ML/\partial \lvert CHOI \rvert < 0$[2]	$(\partial BR/\partial ML)(\partial ML/\partial \lvert CHOI \rvert) \leq 0$
$\partial BR/\partial FB > 0$	$\partial FB/\partial t > 0$[3]	$(\partial BR/\partial FB)(\partial FB/\partial t) > 0$
$\partial BR/\partial FBA < 0$	$\partial FBA/\partial NSA > 0$[4]	$(\partial BR/\partial FBA)(\partial FBA/\partial NSA) < 0$
	$\partial FBA/\partial FB > 0$	$(\partial BR/\partial FBA)(\partial FBA/\partial FB) < 0$
$\partial BR/\partial FZ > 0$	$\partial FZ/\partial TEMP > 0$	$(\partial BR/\partial FZ)(\partial FZ/\partial TEMP) > 0$

[1] Table assumes $S\{t\}<1$. If $S\{t\}>1$, then $CY\{t\}=0$.
[2] Equals zero if $\lvert CHOI \rvert=0$.
[3] Equals zero if $t<21$.
[4] Equals zero if $t<21$.

increases over time. The variable t, on the other hand, records time within the season, decreasing in value as the contract approaches maturity and starting at a new level of about 32 the next season. The concept of a continuous adjustment in coefficients is addressable by subscripting the predicted parameter relationship in the above table by T, with the understanding that this notation implies that the predicted relationship will change in magnitude in a continuous fashion over time. The directions of the trend of predicted adjustments in parameters are shown below, assuming t is held constant. Actual parameter adjustments from observation to observation may vary but a general trend is expected to be exhibited over time.

(5.4) $\partial(\partial BR/\partial RP)/\partial T > 0$, $\partial(\partial BR/\partial CY)/\partial T > 0$,

$\partial(\partial BR/\partial ML)/\partial T = 0$, $\partial(\partial BR/\partial FB)/\partial T < 0$,

$\partial(\partial BR/\partial FBA)/\partial T = 0$, $\partial(\partial BR/\partial FZ)/\partial T < 0$.

Note that the FB{t} parameter is hypothesized to have decreased over time, while the FBA{t} parameter is hypothesized to have remained stable. Thus, the total freeze bias is hypothesized to have decreased over time. This hypothesis reflects the belief that imports will tend to offset the affect of freezes and thus lower the bias as reflected in the total freeze bias adjustment (various combinations of changes in the FB{t} and FBA{t} coefficients will yield this result--the hypothesis cited is the least ambiguous).

It is important to note that changes in the coefficients will not necessarily act in the same direction in determining the total net influence on the basis. Changes in the basis residual may tend to move in different directions for different times of the year. It is hypothesized that the total freeze bias has decrease substantially, resulting in a decrease in the basis during the freeze bias period. It is hypothesized that the basis has tended to widen once the freeze bias period has passed due to changes in the convenience yield and risk premium impacts.

A summary of the hypothesized temporal adjustments within the model is presented in Figures 5.2 through 5.5. The hypothesized impact of T on the coefficients is illustrated with arrows. If the arrow points in towards the origin, then the temporal adjustment results in the graph being pushed in towards the origin. If the arrow points away from the origin, then the temporal adjustment results in the response being pulled out from the origin. The effect of time passing within the season is depicted graphically and is represented by t. The market liquidity effect is not graphed since no hypothesis as to its movement over time is offered. Figure 5.4 illustrates the hypothesized impact on the total freeze bias which is defined as FB{t} + FBA{t}.

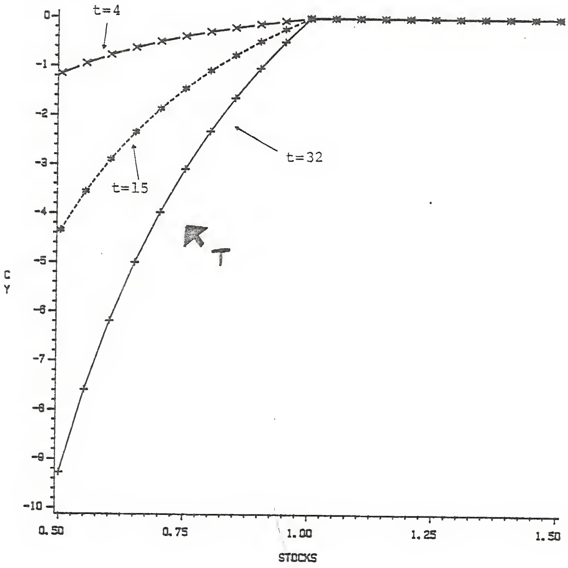

Figure 5.2. Hypothesized change in the CY{t} coefficient over time

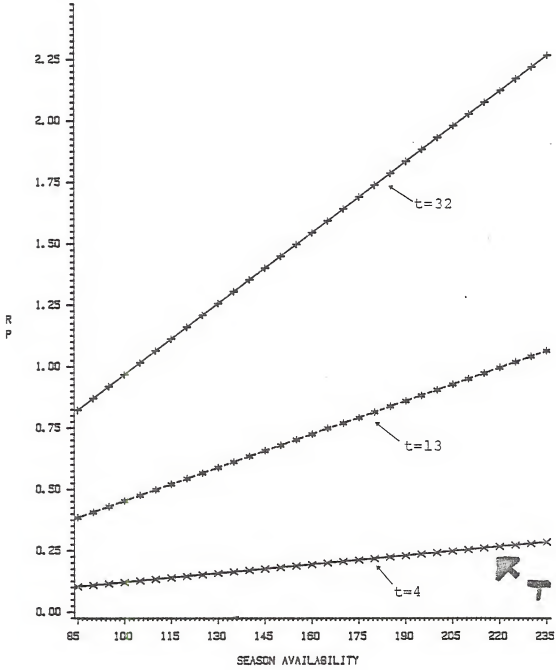

Figure 5.3. Hypothesized change in the RP{t} coefficient over time

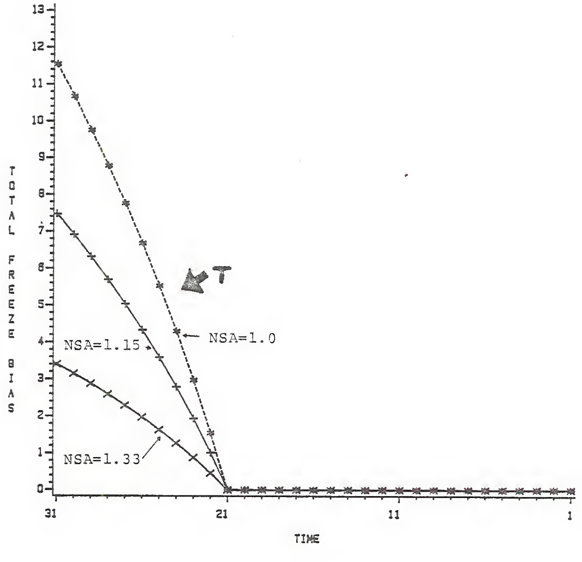

Figure 5.4. Hypothesized change in the total freeze bias over time

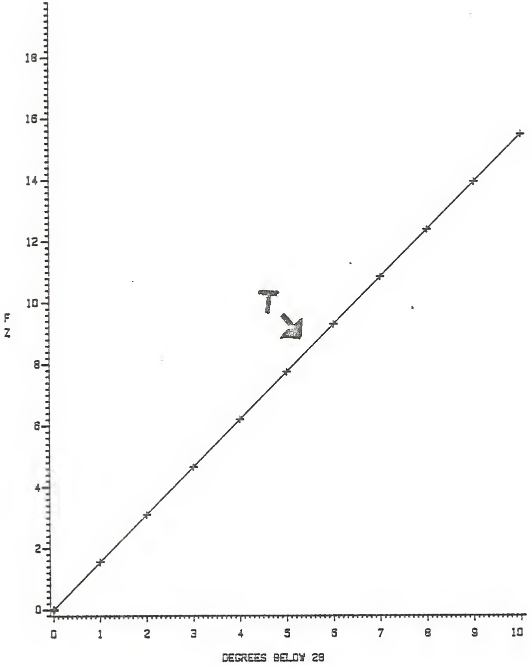

Figure 5.5. Hypothesized change in the FZ{t} coefficient over time

The hypothesized evolution of basis patterns has many implications for futures market users. Generally, understanding how basis patterns have adjusted in the past to changing conditions should prove useful to participants as they access the potential implications of future developments. A decreasing freeze bias should on the average lead to decreased profiting by most short hedgers, who historically have been in a position to profit from the narrowing of the basis that usually occurs throughout winter. A narrowing of the basis is by definition profitable for short hedgers. To the extent that the freeze bias has decreased, one would expect less narrowing of the basis and therefore less profits for short hedgers. Any change in convenience yield, price risk and/or the risk premium would also have direct implications for traders. In accessing the impact of these hypothesized changes on basis patterns, quantification is necessary to decipher total impact. A statement regarding the relative magnitudes of the hypothesized changes is necessary to grasp total impact since these hypothesized changes when considered in isolation can have different implications. Changing of the relative magnitude of basis determinants over time will influence the general shape of the typical basis pattern as time passes. Knowledge of how the basis pattern is fluctuating would be useful to hedgers in their deciding when to get in or out of the market.

The rationale behind and the results of estimates aimed at quantifying the hypothesized changes are presented in the next two chapters. In Chapter VI the Ward-Dasse model is estimated over the original and updated data periods. Interpretation of coefficient changes is included. In Chapter VII a specification using a fixed time from maturity basis residual as the dependent variable is presented, allowing for consideration of more than the July contract and for consideration of the months not covered by the July contract model (and for consideration of seasonal differences during these months). Estimates using time varying parameters were made using these constant period from maturity models. The July contract was not estimated in a time varying parameter framework, due to the discontinuity in the time series that occurs between the period that the contract closes in July one season and December, which is the initial period considered each season. By considering how constant time from maturity models adjust in a time varying parameter framework, it is possible to gain insight into how a specific contract, such as the July contract, would adjust in a similar framework.

CHAPTER VI

ESTIMATION OF THE JULY BASIS MODEL

In this chapter variable specifications and results of re-estimating the Ward-Dasse model over the original and an updated data period are presented. Periods considered are 1967-68 through the 1973-74 seasons and the 1967-68 through 1981-82 seasons. Comparison of the results of the two estimates provides insight into the evolution of FCOJ basis patterns over time. Interpretations are included.

Ordinary least squares estimates were obtained and adjustments for serial correlation made. Ideally, as discussed in Chapter V, estimation procedures that would allow for the estimated coefficients to change over time would be preferred. However, available estimation procedures are not suitable for models that address a discontinuous time period, such as in the Ward-Dasse model. The model encompasses data from December through mid-July of each season. There is a time gap or discontinuity between the final July observation and the beginning of the next season in December. Even if the model was extended to cover the entire year, there would be a discontinuity associated with switching from one contract to the next after contact termination.

In the next chapter the model was specified to allow for a continuous data period. Rather than calculating the basis residual for the July contract, the basis residual used in the next chapter was based on the contract that is a certain fixed time from maturity. Estimates were based on contracts that are two, three, four, five, and six months away from maturity. Time varying parameter estimates were obtained using these residual calculations.

In this chapter results of various model specifications over the original data period are presented first. The purpose of reviewing these specifications is to provide an explanation as to why the final specifications were selected. In the next section the final estimates for the two data periods are presented. A review of some estimation problems encountered follows. Finally, an interpretation of coefficient differences is given.

Initial Estimates

The initial steps in updating the model included collecting data and re-estimation of the Ward-Dasse model over the original data period. Slight differences in the data prevented an exact replication of the original results. For example, Ward-Dasse used a weekly average futures price, while the week's closing futures price is used here. Either price would be appropriate. Similar results would be expected for estimates based on either definition. Since the week's closing futures price data were readily

accessible, this series was used rather than some average weekly price. The market liquidity variable in the present study is defined somewhat differently than in the original model due to the availability of data (the market liquidity variable was insignificant in the original Ward-Dasse estimate). Temperature data in periods subsequent to that considered by Ward-Dasse were not reported for the locations used by Ward-Dasse; hence alternative locations were selected for which temperature data were available for the entire 1967-82 period. The interest rate used here differed from the original model. Ward-Dasse had 226 observations while the attempt to replicate their model was based on 229 observations.

The present study accepts the Ward-Dasse estimate of t* (the period when the FCCJ futures market no longer reacts to potential freezes) and therefore does not make use of maximum likelihood procedures. Ordinary least squares is used for model estimation.

Initial Specification

The initial attempt to replicate the Ward-Dasse model was with the variables defined as follows (though there are some differences in variable specification between the Ward-Dasse and the present estimates, the same notation is used for both). The dependent variable, the July contract basis residual, is defined as

(6.1) $BR\{t\} = E\{t\} - M\{t\}$

where

$BR\{t\}$ = the July basis residual in period t for FCCJ (cents per pound solids),

$B\{t\}$ = FCOJ basis (cents per pound solids),

$M\{t\}$ = storage and interest costs (cents per pound solids).

$B\{t\}$ and $M\{t\}$ are defined as

$$(6.2)\quad B\{t\} = FP\{t\} - (CP\{t\} + TC\{t\})$$

where

$FP\{t\}$ = weekly closing futures price of bulk concentrate (cents per pound solids) (Citrus Associates of the N.Y. Cotton exchange, 1967-74),

$CP\{t\}$ = raw fruit price delivered-in to Florida processors (cents per pound solids) (Florida Canners Association, 1967a-74a),

$TC\{t\}$ = cost of converting fruit into bulk concentrate (cents per pound solids) (Hooks and Kilmer, 1967-82).

$$(6.3)\quad M\{t\} = C\{t\} + (\exp(rt) - 1)(CP\{t\} + TC\{t\})$$

where

$C\{t\}$ = storage cost for Florida processors to carry bulk FCCJ for the length of time remaining on the July futures contract (cents per pound solids) (Hooks and Kilmer, 1967-1982),

$\exp(rt) - 1$ = an adjustment for calculating interest on the initial outlay. t is weeks remaining until the July contract matures. r is the interest rate (Survey of Current Business; 1967-74),

other variables are as defined above.

The basis is calculated using an implied bulk price derived from the fresh fruit price. Alternatively, an implied bulk

price could be derived from the wholesale FOB price. The derivation employed, based on the cash price for fresh fruit, reflects weekly market conditions more so than a derivation based on the wholesale FOB price, which tends to be rigid.

The risk premium refers to the tendency for the futures price to be bid up when anticipated supplies and stocks are high in order to provide protection to stock holders from unexpected price changes. It is operationalized as

(6.4) RP{t} = (SA{t})(t)

where

RP{t} = risk premium,

SA{t} = projected availability of stocks for the season (USDA Crop forecast for Florida 1,000 boxes) (Florida Citrus Mutual, 1968-1975),

t = weeks until the July FCOJ futures contract matures.

Convenience yield addresses the tendency for the cash price to be bid up relative to the futures price when inventories are low. The convenience yield variable is based on weeks of supplies on hand for Florida processors, which is defined as

(6.5) I{t} = (INV{t} / YRMOV{t})(52)

where

I{t} = weeks of supplies on hand,

INV{t} = inventory of FCOJ held by Florida processors at the end of week t (thousands of gallons) (Florida Canners Association, 1966-74b),

YRMOV{t} = total movement of FCOJ for Florida processors for the current week and the previous 51 weeks (thousands of gallons) (Florida Canners Association, 1966-74b).

Define S{t} as the ratio of current inventories (I{t}) to normal inventories for the current week of the season (MI{t}). MI{t} is the average value of I{t} calculated over the 1958-59 to 1973-74 seasons for each week of the season. Convenience yield is defined as

$$(6.6) \quad CY\{t\} = ((1/(S\{t\}) - 1)(t), \text{ if } 0 < S\{t\} \leq 1$$
$$= 0 \qquad , \text{ if } S\{t\} > 1 .$$

If inventories were above the norm, then CY{t} equals zero. The lower inventories are relative to the norm, the greater CY{t} . As the contract approaches maturity, t will decrease, causing CY{t} to approach zero as the contract matures. At maturity t and thus CY{t} equals zero.

The market liquidity variable measures volume of trading relative to changes in open interest. It was defined as

$$(6.7) \quad ML\{t\} = V\{t\} / |CHOI\{t\}| , \text{ if } |CHOI\{t\}| > 0$$
$$= 0 \qquad , \text{ if } |CHOI\{t\}| = 0$$

where

ML{t} = market liquidity,

V{t} = volume of contracts traded on closing trading day of week (number of contracts) (Citrus Associates of the N.Y. Cotton Exchange, 1967-74),

|CHOI{t}| = absolute value of the current week's closing open interest minus the previous week's closing open interest (number of contracts per day) (Citrus Associates of the N.Y. Cotton Exchange, 1967-74).

The greater the volume is to relative the change in open interest, the more likely it is that the futures price represents an even balancing of speculative and hedging interests and that easy entry and exit into the market is possible.

Ward-Dasse referred to the bidding up the basis in winter months as the freeze bias. They operationalized the freeze bias variable as

$$(6.8) \quad FB\{t\} = \ln(\,(t - t^*) \,/\, (\max t - t^*)\,) \quad, \text{if } t \geq t^*$$
$$= \quad 0 \qquad\qquad\qquad\qquad\qquad\qquad\qquad , \text{if } t = t^*$$

where

$FB\{t\}$ = freeze bias,

t = weeks remaining before the July contract matures,

$\max t$ = maximum value of t for the data period,

t^* = some t value that correspond to the week when the futures market no longer reflects the possibility of a freeze.

Ward-Dasse estimated t^* to be 21. The value of $\max t$ for the data period considered here is 32. Substituting these values into 6.8 yields the definition of freeze bias used in the current study

$$(6.9) \quad FB\{t\} = \ln(t - 21) \,/\, 11 \quad, \text{if } t \geq 21$$
$$= \quad 0 \qquad\qquad\qquad , \text{if } t < 21 \,.$$

The greater the season's availability of stocks, the less the expected impact of a freeze on prices and thus the less the bidding up of the basis in winter months. Ward and Dasse accounted for this tendency by including a freeze bias adjustment variable. It is defined here as

(6.10) $FBA\{t\} = (FB\{t\})(NSA\{t\})$

where

FBA{t} = freeze bias adjustment,

FB{t} = freeze bias (defined above),

NSA{t} = relative availability of projected stocks; NSA{t} = SA{t} / MSA{t} where SA{t} is projected stocks available for the season (as defined earlier) and MSA{t} is the mean value of SA{t} calculated for each week of the season (average based on the 1967-74 seasons).

The freeze variable addresses the tendency for the futures price to react quicker than the fruit cash price to the potential damage from freeze. It is defined as

(6.11) $FZ\{t\} = (TEMP1\{t\} + TEMP2\{t\} + TEMP3\{t\})/3$

where

FZ{t} = freeze (degrees below 28),

TEMP1{t} = the number of degrees below 28 reported for Sanford, Florida, based on the coldest recorded temperature for the current week. If the temperature has not fallen below 28 during the week, then TEMP1{t} = 0, TEMP2{t} and TEMP3{t} are similarly defined for the towns of Clermont, Florida and Mountain Lake, Florida (Florida Crop and Livestock Reporting Service, 1967-74).

Table 6.1 lists means and standard deviations for the variables used in estimating the model over the original data period. Variables not discussed yet are included in the table. A similar listing covering the period considered by the updated model is presented in Table 6.2.

Table 6.1. Variable means and standard deviations for the 1967-68 through 1973-74 seasons (229 observations)

Variable Notation	Variable Description	Mean	Standard Deviation
BR{t}	July basis residual	-.8948	5.4923
CY{t}	Convenience yield (based on S)		
CY1{t}	Convenience yield (based on S1)	1.955	3.730
FB{t}	Freeze bias	.1345	.2214
FBA{t}	Freeze bias adjustment	.1372	.2302
FZ{t}	Freeze (effect of 1 week)	-[1]	-
FZ3{t}	Freeze (effect of 3 weeks)	-	-
FZ4S1{t}	Freeze (declining 4 week effect influenced by inventory)	-	-
ML{t}	Market liquidity	15.36	28.39
t	Weeks until July contract matures	-	-
RP{t}	Risk premium (SA{t}) (t)	2297.3	1456.1
RP1{t}	Risk premium (SA{t}) (ln(t+1))	371.53	139.12
S{t}	Relative inventory (base: 1959-73)	1.0	.1989
S1{t}	Relative inventory (base: 1968-73)	1.0	.2014
SA{t}	Predicted season's availability	144.60	23.496

[1] Freezes in terms of degree below 28 for the period were: 3.33, .67, 3.67, and 4.67.

Table 6.2. Variable means and standard deviations for the 1967-68 through 1981-82 seasons (489 observations)

Variable Notation	Variable Description	Mean	Standard Deviation
BR{t}	July basis residual	-1.6742	4.525
CY2{t}	Convenience Yield (based on S{t})	1.7094	3.562
FB{t}	Freeze bias	.1367	.2229
FBA{t}	Freeze bias adjustment	.1370	.2200
FZ4S2{t}	Freeze (declining 4 week influenced by S2{t})	-[1]	-
ML{t}	Market liquidity	17.74	33.15
t	Weeks until maturity	15.996	9.437
RP{t}	Risk premium (SA{t}) (t)	2632.4	1603.1
RP1{t}	Risk premium (SA{t}) (ln(t+1))	423.03	160.13
S2{t}	Relative inventory (base seasons: 1968-82)	1.0	.18436
SA{t}	Predicted season availability	163.380	28.11

[1] Freezes in terms of degrees below 28 for the period were: 3.33, .67, 3.67, 4.67, 5.33, 0.67, 2.33, 8.67, and 3.33.

Other Specifications

Initial attempts to replicate the Ward-Dasse results were relatively poor, especially for the convenience yield and freeze coefficients and t-statistics (depicted by equation B in Table 6.3; equation A in the table reviews Ward-Dasse's results, which are reported in terms of the variable units used in the present study).

At this point in the study a careful review of the data and variable definitions was undertaken. Closer examination of the Ward-Dasse report suggested that they may have defined their freeze variable as degrees below 28 during the freeze week. During subsequent weeks the variable would maintain this value until the cash market adjusted to the freeze at which point the variable would take the value of zero. Examination of the reactions of the futures and spot prices to a freeze suggests that the futures price reacts immediately, while the spot price takes approximately three or four weeks until it has essentially fully adjusted. By defining a freeze variable (FZ3{t}) as degrees below 28 during the freeze week and maintaining this value for the next two weeks the results improved but were still not satisfactory (equation C in Table 6.3). The relatively weak convenience yield effect was the primary concern.

Failure to adequately account for the impact of a freeze was a primary drawback of the models considered. A freeze results in a major increase in the basis that lasts for

Table 6.3. Intial estimates of the July basis residual model over the original data period (1967-74)

Constant	Risk Premium	Convenience Yield	Market Liquity	Freeze Bias FB{t}	Freeze Bias FBA{t}	Freeze
A. The Ward-Dasse results:						
	RP{t}	CY{t}	ML{t}	FB{t}	FBA{t}	FZ{t}
-2.66	.0003022	-.29	.00454	36.71	-25.16	1.55
(4.93)[1]	(1.26)	(-4.14)	(0.083)	(7.18)	(-4.74)	(7.06)
B. Initial attempt to replicate Ward-Dasse:						
	RP{t}	CY{t}	ML{t}	FB{t}	FBA{t}	FZ{t}
-3.92	.0007629	-.09206	-.00845	44.54	-33.20	2.503
(-6.53)	(2.41)	(-1.16)	(0.90)	(7.15)	(-5.19)	(4.33)
other statistics:		R^2=.4834				
C. As B but with a three week freeze effect:						
	RP{t}	CY{t}	ML{t}	FB{t}	FBA{t}	FZ3{t}
-3.759	.0005771	-.11064	-.00571	43.76	-32.19	2.400
(-6.65)	(1.93)	(-1.48)	(0.642)	(7.47)	(-5.35)	(7.07)
other statistics:		R^2= .5428				
D. As B but with a four week, declining freeze effect that is influenced by processors' inventory and with different base years used in defining average inventories:						
	RP{t}	CY{t}	ML{t}	FB{t}	FBA{t}	FZ4S1{t}
-3.711	.0006092	-.21232	-.00673	43.84	-32.25	2.864
(-6.78)	(2.11)	(-3.00)	(-0.78)	(7.65)	(-5.51)	(8.09)
other statistics:		R^2=.5685				

[1] t statistics are in parenthesis.

several weeks. Errors in estimation will tend to be relatively large following a freeze if the freeze has not been adequately accounted for, which might well influence the estimated coefficients of the other variables in the model. A revised estimate was made dropping the observations for freeze weeks and the six weeks following a freeze. The results improved considerably, lending support to the arguments that the impact of a freeze should be re-evaluated.

In specifying the freeze variable two additional factors were considered in addition to the extent of the freeze. Firstly, the cash price does not fully adjust immediately. The adjustment is gradual and it takes several weeks for full adjustment to occur. Thus, one would expect the widening of the basis to be greatest during the freeze week and for the extent of the widening to decrease in subsequent weeks until the cash market has fully adjusted. Secondly, the influence of a freeze on FCB prices and industry prices generally will tend to depend on processors' inventory position. If inventories were relatively high, one would expect less of an adjustment in prices than if inventories were relatively low for freezes of equal magnitude since inventories serve as an alternative source of supplies for crop lost to a freeze. In that the futures price increase following a freeze is an anticipation of the eventual adjustment in cash prices, one would expect the increase in

the futures price and the basis to reflect inventory conditions. Failure to fully reflect the effect of inventories in accounting for a freeze should hamper the measurement of convenience yield, which is also a function of inventories. Convenience yield refers to a lowering of the basis when inventories are low, which is the opposite of the effect of inventories during a freeze period. An alternative freeze variable was defined as

$$(6.12)\quad FZ4S1 = (FZ4\{t\} / S1\{t\})(\ln(e - ((TZ\{t\})(e-1)/4)))$$

where

FZ4S1{t} = freeze,

FZ4{t} = similar to FZ3{t} but the effect of the freeze lasts four weeks instead of three. FZ4{t} is defined as the degrees below 28 for the cited locations during the freeze week and the next three weeks (Florida Crop and Livestock Reporting Service, 1967-74);

S1{t} = relative inventory level for the current week. Defined as S{t} but with the base period used in defining average inventories being the 1967-68 seasons through the 1973-74 seasons (Florida Canners Association, 1966-74b),

TZ{t} = equals 0 during freeze week, 1 for the week following a freeze, 2 the next week, 3 the next week, and 4 for subsequent weeks.

Note that FZ4S1{t} is defined such that the effect of a freeze on relative prices lasts for four weeks. The freeze effect declines over time. FZ4S1{t} is the greatest during the freeze week and zero after five weeks. Lower inventories

will increase the value of FZ4S1(t), reflecting the belief that the impact of a freeze on prices is greater at low inventories.

Note that FZ4S1(t) is defined using S1(t) (S1(t) is defined as S(t) but using average weekly inventories calculated from the 1967-68 season through the 1973-74 season) (S(t) was used by Ward-Dasse and is used in defining CY(t) in the models discussed to this point--S(t) is based on inventories from the 1958-59 through the 1973-74 seasons). Various time periods were considered in defining mean inventory levels. The results using different time spans were very similar, owing to the fact that processors have followed similar inventory policies over the years. The decision to use S1(t) rather than S(t) was based primarily on convenience. Dasse (1975) reports average inventory levels for the longer time period but only for the first eight months of the season. Since the time varying parameter models presented in the next chapter call for an inventory variable throughout the year, it was easier to consider only the 1967-74 period rather than collect data back to 1957. For consistency the shorter period was adopted for the final estimates of the July basis models also. Similarly, S1(t) was used in defining convenience yield rather than S(t) (the new variable was denoted CY1(t)).

Equation D in Table 6.3 presents the results using FZ4S1{t} as the freeze variable and CY1{t} as the convenience yield variable. The estimated coefficients, t-tests, and R^2's are reasonably similar to those reported by Ward-Dasse. At this point models addressing the longer time period (1967-82) were considered. Though another adjustment (disussed below) was made in the shorter period model to allow for comparisons with the updated version.

Final Estimates

The model as defined above was estimated over the longer data period with changes in the base years used in formulating index variables to reflect the longer data periods considered. The mean season availability variable and the mean inventory variable were redefined to correspond to the data period encompassed by the model (i.e. calculated using observations from the 1967-68 season through the 1981-82 season). Average weekly season's availability is used in calculating the freeze bias adjustment variable which is denoted as FBA2{t} in the expanded model to distinguish it from the FBA{2} notation of the shorter period model. The convenience yield and freeze variables are denoted CY2{t} and FZ4S2{t} respectively in the longer period model and are defined the same as CY1{t} and FZ4S1{t} except they were based on S2{t} rather than S1{t}; S2{t} was defined as current inventories weighted by the average inventory variable for the current week of the season. This average was based on the 1967-82 period.

The results of this specification were not plausible in that they did not conform to theoretical expectations. The total freeze bias effect, measured as FB{t} plus FBA2{t}, was less than zero for most values of season availability during the data period, which is theoretically unreasonable. Also, the coefficient for the risk premium variable increased tremendously relative to the shorter period estimate. It appears that the model's specification was not able to isolate the effects of the freeze bias and risk premium with the variables FBA2{t}, FB{t} and RP{t}. Note that SA{t} is used in defining both FBA{t} and RP{t}. An SA{t} value that resulted in a negative value for the total freeze bias effect would be offset by considering RP{t}. By multiplying SA{t} by the natural log of t+1 rather than t in defining the risk premium variable, the estimated coefficients improved though it is possible that this respecification did not allow for complete isolation of the freeze bias and risk premium effects. This alternative definition of risk premium is denoted as RP1{t}. Note that RP1{t} is relatively smaller than RP{t} during winter. Using RP1{t} rather than RP{t} resulted in a larger portion of the relatively large winter basis being accounted for by the freeze bias variable. Evidently, the change in RP1{t} from week to week, which is smaller than the change in RP{t} from week to week, was a better approximation of how the risk premium actually adjusts as maturity approaches.

Results and Review of Variable Definitions

The final estimates adopted for the two time periods considered are presented in Table 6.4. To allow for consistency between models, RP1{t} replaced RP{t} in the final shorter period model (the model adopted is the same as equation D in Table 6.3 except for RP1{t} replacing RP{t}). A review of variable definitions in the final models adopted is presented in Table 6.5.

In reviewing the coefficient changes most results were as hypothesized. The risk premium and convenience yield increased over time and total freeze bias (FB{t} - FBA{t}) decreased. The increase in the freeze coefficient was not expected. Market liquidity became a significant variable in the updated version and the constant term became more negative.

Serial Correlation

Investigation revealed that the error correlation tended to change over time for both estimates. Estimates corrected for serial correlation are also presented in Table 6.4.

The following correction procedure was followed for each data period. Based on the estimated model errors were calculated for each observation period. The current period error was regressed against the lagged error for each season in the data period to estimate a separate ϕ*{i} for each season as depicted below.

(6.13) $u\{s\} = \phi^*\{i\}u\{s-1\} + \epsilon\{s\}$

where

Table 6.4. Final estimates of the July basis residual model

Constant	Risk Premium	Convenience Yield	Market Liquity	Freeze Bias FB{t}	Freeze Bias FBA{t}	Freeze
A. Results for the 1967-68 through 1973-74 seasons:						
	RP1{t}	CY1{t}	ML{t}	FB{t}	FBA{t}	FZ4S1{t}
-3.282	.001571	-.20177	-.00511	42.83	-28.82	2.909
(-4.17)[1]	(0.70)	(2.83)	(0.59)	(7.30)	(-4.96)	(8.15)
other statistics: R^2 =.5608						
B. Results for the 1967-68 through 1981-82 seasons:						
	RP1{t}	CY2{t}	ML{t}	FB{t}	FBA2{t}	FZ4S2{t}
-8.128	.011679	.02520	-.02212	37.40	-30.71	4.687
(-7.20)	(4.07)	(0.24)	(-2.10)	(4.42)	(-3.61)	(12.18)
other statistics: R^2=.3669						
C. Correcting B for serial correlation:						
	RP1{t}	CY2{t}	ML{t}	FB{t}	FBA2{t}	FZ4S2{t}
-4.225	.002594	-.00668	-.00827	124.31	-118.72	3.134
(-2.99)	(0.72)	(-0.37)	(-2.05)	(4.06)	(-3.80)	(11.93)
D. Correcting A for serial correlation:						
	RP1{t}	CY1{t}	ML{t}	FB{t}	FBA{t}	FZ4S1{t}
-2.626	-.000422	.06266	-.00459	67.23	-47.38	2.144
(2.38)	(-0.14)	(0.36)	(-1.02)	(3.12)	(-2.33)	(6.96)

[1] t statistics are in parenthesis.

Table 6.5. Review of variable definitions

Variable	Definitions		
CY1{t}	= (1 - (1 / S1{t})) (t)	if S1{t} <1	Convenience
	= 0	if S1{t} >1	yield
CY2{t}	= (1 - (1 / S2{t})) (t)	if S2{t} <1	Convenience
	= 0	if S2{t} >1	yield
FB{t}	= ln((t - 21) / 11)	if t>21	Freeze bias
	= 0	if t<22	
FBA{t}	= (FB{t}) (NSA{t})		Freeze bias adjustment
FZ4S1{t}	= (FZ4{t} / S1{t}) (ln (e - ((TZ{t}) (e-1)/4))		Freeze
FZ4S2{t}	= (FZ4{t} / S2{t}) (ln (e - ((TZ{t}) (e-1)/4))		Freeze
RP1{t}	= (SA{t}) (ln(t+1))		Risk premium
ML{t}	= V{t} / |CHCI{t}|	if CHOI > 0	Market liquity
	= V{t}	if |CHCI{t}| =0	

Component variables:

FZ4{t} = Degrees below 28 during freeze week and the following three weeks.

NSA{t} = SA{t} / MSA{t} ; MSA{t} is average value of SA{t} for the present week of the season - average based on the 1967-68 season through 1973-74 season for the shorter period model and 1967-68 season through 1981-82 season for the longer period model.

S1{t} = Current inventories divided by movement for the past year (called I{t}) weighted by MI{t} for the current week of the season. MI{t} is the average value of I{t} for the present week of the season; average based on 1967-68 season through 1973-74 season.

S2{t} = Defined as S1{t} with MI{t} being based on the 1967-68 season through 1973-74 season.

SA{t} = Projected season's availability of stocks.

t = Weeks remaining until July contract matures (begins with a value of 31 or 32 each season and decreases to 0).

Table 6.5--continued

Variable Definitions		
TZ{t}	=	0 during freeze week, 1 for the week following a freeze, 2 the next week, 3 the next week, and 4 for subsequent weeks.
V{t}	=	Volume of July contracts traded during last trading day of week.
|CHOI{t}|	=	Absolute value of the current week's open interest minus the previous week's closing interest for the July contract (number of contracts per day).

$u\{s\}$ = the estimation error for period s in a particular season i (s begins at 1 each new season and increases by 1 each period within the season),

$\phi^*\{i\}$ = estimated relationship between current and lagged estimation error for the ith season,

$e\{s\}$ = error term.

The dependent and independent variables are transformed as

(6.14) $X^*\{s\} = X\{s\} - \phi^*\{i\}X\{s-1\}$

where

$X^*\{s\}$ = the value of the transformed dependent or independent variable for period s,

$X\{s\}$ = untransformed value for period s.

The first observation period for each season was deleted from the data and ordinary least squares was used to estimate with the transformed model.

Since changes in ϕ^* from season to season did not exhibit a noticable trend, no attempt was made to investigate a more complex error process. Estimates were also made based on a constant over time using the Ward-Dasse procedure for dealing with the discontinuity of the data across seasons. Allowing ϕ^* to vary over seasons yielded more plausible results.

Review of Estimation Problems

To this point in this chapter a logically sequential explanation for the final specification of the July basis models has been set forth. Other topics useful to understanding and interpreting the estimated relationships

are discussed below along with the results of specifications not yet covered.

One point that has been alluded to earlier is the relative importance of modeling winter months. The July basis is largest during winter due to the freeze bias and the relative distance the contract is away from maturity. Three of the six explanatory variables have a zero value during non-winter months. One would expect that for non-winter months the basis would be relatively easier to model and predict. The diversity of the causes of winter basis patterns make it more difficult to model. For example, it has been noted how the specifications of the various freeze variables considered influenced the convenience yield coefficient and how the specification of the time component for risk premium influenced freeze bias. Compounding measurement problems in winter months is the strong impact that freezes can have on the basis and the difficulty of explaining why this impact varies. Quantification is made more difficult by the fact that much data that would be useful in modeling the impact of a freeze is not available immediately following a freeze and thus cannot be incorporated into the model. The reaction of the futures price following a freeze is a reaction that is based on little information. The initial futures price adjustment is often significantly different from the final adjustment as additional information becomes available. Sometimes months

pass until an accurate account of crop loss is available, which can lead to additional price adjustment throughout the industry (Florida Crop and Livestock Reporting Service, 1982).

Convenience yield presented the greatest measurement problem. Several alternative definitions in addition to those cited earlier were considered. The estimated results using these alternative definitions were very sensitive to the definition used. By defining convenience yield using a mean inventory variable based and current inventory and the inventory levels of one and two years ago, the results were much better than those reported for the shorter data period. Using an average over four or five years, however, resulted in poor estimates. Thus, the three year average model was discarded since the averaging procedure appeared arbitrary. Results using an average inventory measure over a relatively long data period, such as S{t}, S1{t}, and S2{t}, were similar.

Another concern is the tendency for SA{t} to increase over time. This trend presents a problem in interpreting the freeze bias adjustment coefficients for the short and long data period models. The total freeze bias effect will tend to be greater than suggested by the model's coefficients in later years and less in earlier years. SA{t} was weighted by yearly movement in defining an alternative freeze bias adjustment variable, which lessened

the trend over time. However, it was not possible to measure total freeze bias in this manner. No other weighting procedure appeared theoretically plausible.

Interpretation of the Revised Ward-Dasse Model

Unfortunately little insight into the nature of parameter changes or stability can be gained by comparing the July contract estimates. A major problem in interpretation is deciding whether to use the original results or those corrected for serial correlation. The original, non-corrected estimates are unbiased. However, serial correlation is clearly a problem and should be accounted for. The nature of the error process is not obvious and different results will be obtained using different assumptions.

Comparing the non-corrected estimates, it is clear that the results were different (it is not possible to use a statistical test to compare differences in coefficient estimates across data periods because the specifications of the models were different due to differences in indexing). Over the longer data period, the risk premium and market liquidity variable impacts are relatively strong, while the convenience yield is weak. The opposite occurs in the shorter data period, which shows a strong convenience yield. When corrected for serial correlation, only the market liquidity variable for the longer data period is significant and all three are insignificant for the shorter data period.

One explanation for these results is that the model specification was not precise enough to accurately measure the theoretical concepts involved. According to this view the large increase in the risk premium effect for the non-corrected, longer data period estimate at the expense of the convenience yield. This storage risk premium effect for the longer data period might well have a negative constant component which accounts for the more negative constant term for the longer data period estimate. The results implied, as explained earlier, that the risk premium and freeze bias effects were interrelated forcing a change in the time component definition to yield reasonable estimates. A problem in indexing might exist. Maybe additional indexing is needed. For example, the risk premium variable does not take into account market size in operationalizing season's availability (attempts to make such allowances were not successful). Similarly, market size has no effect on the freeze bias adjustment. The time component, somewhat arbitrarily defined, might add additional complications. The implied changes across data periods for the non-corrected estimates are difficult to accept.

If one accepts the estimates corrected for serial correlation as a measure of parameter changes, then changes in the constant, market liquidity and freeze effect are implied. The market liquidity effect is twice as strong over the longer data period. However, the impact of

liquidity is very small. The difference in impact has no practical usefulness to traders.

A freeze will have a more positive impact on the residual for the longer data period model. A freeze of 27 degrees occuring at normal stock levels will increase the residual 3.134 cents per pound solids for the longer data period model. During the week of a freeze the difference is 0.99 cents more than the impact over the shorter period. The number of degrees below 28 degrees multiplied by 0.99 yields the difference in effect across data periods for freezes of different intensities at normal stock levels. The increased residual following a freeze decreased in following weeks as described earlier. These general results were multiplied by the inverse of stocks to decrease the effect of a freeze on prices. The non-corrected results suggest that the impact is 1.778 cents greater over the longer data period at normal stock levels. Due to the difference in constant terms for both the original and corrected results, one cannot conclude that the residual will be greater following a freeze in more recent years since the constant terms are more negative for the longer data period estimates.

The results corrected for serial correlation suggest that the total freeze bias effect is greater for the longer data period. However, if one considers the difference in constant terms and other variable coefficients across

estimates. The total freeze bias effect for the shorter data period estimate during freeze bias weeks equals

(6.15) $\text{Bias1} = (67.230 - ((47.376)(SA\{t\}/142))(\ln(t-21/11)).$

Actually average availability will vary slightly from week to week, but be equal for the same weeks in different years. A value of 142 for average availability is representative. Assuming SA{t}, season availability, is at its normal level, 142, then the total bias equals

(6.16) $\text{Bias1}\{|SA=142\} = (19.854)(\ln(t-21/11)).$

The total bias effect for the longer data period, corrected for serial correlation, equals

(6.17) $\text{Bias2} = (124.308-((118.714)(SA\{t\}/166))(\ln(t-21/11)).$

For the longer data period an average availability of 166 is representative, reflecting the tendency for the crop forecast to increase over the data period. Evaluating at SA{t} equal to 142 to allow for comparison with the shorter data period bias yields

(6.18) $\text{Bias2}\{|SA=142\} = (22.7532)(\ln(t-21/11)).$

Thus, when corrected for serial correlation, the bias is greater over the longer data period and for this example the difference is

(6.19) $\text{Bias2}\{|SA\{t\}=142\} - \text{Bias1}\{|SA\{t\}=142\} = (2.854)(\ln(t-21/11)).$

This result does not imply that the residual for the longer data period will be larger in winter. Differences in other coefficient values across data periods, notably the constant terms, must be considered. Which residual is the larger will depend on the variable values used.

Unfortunately, different implications result if serial correlation is treated differently. The opposite implication is found using the results not corrected for serial correlation. A stronger bias exists for the shorter data period is the result. Evaluating the bias of each estimate assuming SA{t} equals 142 the bias for the shorter period is larger by a factor of

(6.20) Bias1{|SA{t}=142} - Bias2{|SA{t}=142} = (2.966)(ln(t-21/11)).

The difference in risk premium impacts is stronger over the longer data period and acts to lessen actual residual differences during the winter. Difficulties were encountered in attempting to isolate the impacts of the bias and risk premium both of which are a function of SA{t}.

In conclusion, the results of updating the July contract model and comparing results sheds little light on the question of parameter changes over time. Indexing problems related to market growth and increased U.S. production may have been the source of estimation problems. Perhaps more definite conclusions could be reached if the Ward-Dasse model was to be respecified to account for these potential

problems. In the next chapter the model is respecified to account for residual movements across the entire season. Specifications considered do attempt to avoid indexing problems. By defining the basis residual in terms of a constant period away from maturity, a continuous data period is made possible, allowing for time varying parameter estimates. These estimates provide another, an hopefully more accurate, estimate of changes to those discussed in this chapter.

CHAPTER VII

SPECIFICATION AND ESTIMATION OF CONSTANT PERIOD FROM MATURITY MODELS

The objective of this chapter is to present the specifications and results of constant period from maturity models for the FCOJ basis residual. These models are estimated with the objective of quantifying temporal changes in the estimated FCOJ basis residual relationships.

The label constant period from maturity models is used to distinguish these models from constant contract models which use the basis residual of a specific contract as the dependent variable (such as the July contract in the previous chapter). Models for two, three, four, five, and six months from maturity are considered.

A comparison of constant contract and constant period from maturity models is made. A discussion on modeling the FCOJ basis residual in a constant period from maturity framework is presented. An alternative way to operationalize the convenience yield and risk premium concepts is discussed and used in the subsequent models. The main purpose of these above cited sections is to provide a transition from the July contract specification to how the

constant period models were specified. The first model presented represents an initial attempt to specify the Ward-Dasse model in a constant period from maturity framework. The logic behind the specification and where it differs from the July model is explained. Alternative specifications are reviewed to explain or document why the final specification was selected.

Constant Period Versus Constant Contract Models

The difference in constant contract and constant period from maturity models depends primarily on how futures contract prices are used. The constant period model holds constant the length of time from maturity and thus uses a number of futures contracts. For the constant contract model the length of time from maturity varies and the futures contract modeled is constant. Assuming the modeler has perfect insight into the factors involved in determining the basis and assuming that these factors are fully reflected in the models estimated, then one should theoretically be able to translate the results from a constant contract model into a constant period model and vice versa, obtaining similar results with either model. There are estimation differences built into each specification.

An advantage of considering only one contract is that it allows for easier isolation of seasonal factors. For the July FCOJ contract, for example, one has a clear idea what

periods to expect to find the freeze bias and its general shape over time. Seasonal factors may be more difficult to identify and isolate with constant period from maturity models. Once again consider the freeze bias. Note that the extent of the freeze bias at a particular time may well depend on the contract considered; if the contract matures before the freeze period, then the extent of the bias should be minimal (some bias is possible due to arbitrage among contracts). If the contract matures in the middle of the freeze period, less actual bias might be expected when compared to a contract that matures immediately after the freeze period. During the winter months when the specific contract included in the basis residual definition changes to another contract, one might expect some shift or change in the freeze bias measure depending on the contracts involved. If this switch in contracts is not explicitly accounted for in the model, then there may be some loss in explanatory power. (More details about the modeling of seasonal variations of the FCOJ basis follows in the next section.)

When seasonal influences interact with the time of contract maturity, such as with the freeze bias, it is less difficult and more straight forward to model it with a constant contract model. If the seasonal factor is purely cyclical, then it can be modeled equally well by either technique.

A disadvantage of the constant contract approach arises from difficulties in specifying time dependent variables (which are constructed by multiplying traditional variable definitions by a function of time away from maturity). The time component may shift discretely from period to period for particular periods of time from maturity. Operationalizing the time component with relatively simple functional forms such as t or log (t+1) may not adequately reflect the basis pattern as the contract approaches maturity. Theory offers little guidance to the appropriate functional form for the time component. Since the time away from maturity is constant or virtually so for constant period from maturity models, none of the explanatory variables include the time components (t) similar to those used in the Ward-Dasse model.

By comparing the estimated coefficients of different constant period models, insight could be gained into how to better specify the time components for the constant contract models. Understanding and measuring seasonal factors could be originally gained through constant contract models and then worked into the constant period models since seasonal factors are usually more easily incorporated into a constant period model. Additional changes in both specifications could be made based on the results of the revised specifications.

Specifying a Constant Period Model for FCOJ

Seasonal fluctuations in basis patterns and differences in the data requirements are the main issues that need to be addressed when specifying and estimating the July contract model in a constant period from maturity framework. Differences in data used in defining the basis residual also allow for a slightly different treatment of basic storage theory concepts in specifying the constant period models.

Accounting for Seasonal Fluctuations

As discussed in the previous section, the concept of a freeze bias is more difficult to measure with the constant period to maturity model. Slight differences in the general shape of the freeze bias may in reality exist for models representing different months to maturity. For example, the span of the freeze bias may differ since different contracts are used in defining the basis residual before and during the freeze period. Switching from one contract to the next during the freeze bias period may lead to discontinuous jumps in the freeze bias variable.

Since the constant period models cover the entire year and the July contract model only extends from December to July, the freeze bias definition is expanded to include data periods before December. In the initial models discussed, the freeze bias variable was defined so that it begins in October, peaks in December and ended in February. The definition is somewhat arbitrary but follows the definition

used for the July model from December through February. Difficulties with the above specification led to alternative treatments of the freeze bias and seasonal fluctuations. The nature of these alternatives are addressed later.

Problems were also encountered in attempting to adapt Ward-Dasse's risk premium variable (RP{t}). Ward-Dasse defined RP{t} as the crop forecast multiplied by a time component. In a constant period from maturity framework the corresponding risk premium definition is the crop forecast. The problem being that the crop forecast and the relevant futures price will not always be for the same season. If, for example, the observation period falls in July, then for a six month from maturity model the relevant futures price would be the January futures price. The crop forecast is for the current season, while the futures price falls in the following season. During July there is some expectation regarding next season's crop that influences the January futures price. However, quantifying this expectation is difficult. The U.S.D.A. crop forecast for the coming season is not released until October. Clearly, the January futures price is influenced somewhat by the expected current season's crop, but more is involved in determining expected supplies.

No solution to this problem was evident. Ward-Dasse's risk premium concept is simply operationalized as the current crop forecast. The definition is more suited for

nearby basis models, such as the two month from maturity model.

Data Considerations

The constant period from maturity models span the entire year, while the July contract model does not. The difference in periods encompassed necessitates a change in data used for the spot price.

Following Ward-Dasse and the July model specifications presented in the previous chapter, a derived spot price was employed based on the cash price for Florida fruit plus costs associated with transforming the fruit to orange concentrate. Typically, there is no reported cash price for Florida oranges from mid-July to October or November because little or no fruit is harvested.

Two alternative variables that could be used in defining an alternative spot price were considered--the Florida wholesale FOB price for retail sized FCOJ and the Florida FOB price for bulk concentrate. Attempts to fill in the gap in the spot price data with one of these variables resulted in relatively large price shifts for those periods were the spot price was missing. (The history of these prices was reviewed in Figure 4.3 and the corresponding basis residual values were presented in Figure 4.2.)

The wholesale FOB price for FCOJ, discussed in Chapter IV, is generally reasonably stable, typically changing only a few times each year. Using this price to derive a spot

price results in a price that will tend to exhibit infrequent discrete shifts a few times each year. The Ward-Dasse model was constructed to account for smoother adjustments in the basis over time. When the Ward-Dasse model was translated into a constant period from maturity framework and the wholesale FOB price used as the spot price, the explanatory capabilities of the model were very poor.

Using the FOB bulk price (see Chapter IV) as the spot price in defining the basis residual results in theoretically justifiable signs for the estimated coefficients. It is reasonable to expect the empirical results to differ somewhat when comparing a basis defined with the cash fruit price versus using the bulk FOB price. The cash price is the most sensitive to supply conditions (Ward and Kilmer,1980). When supplies are high, the cash price will tend to be relatively low. Given short supplies, the cash price tends to be relatively high compared to other times. These tendencies reflect the fact that most fruit is marketed through cooperatives and participation plans and thus is committed prior to actual sales. The bulk FOB price is probably the most representative of the economic value of the orange supplies for processors. Being directly controlled by processors, the bulk price is probably more reflective of processor policies than is the fruit cash price. Its use in defining the basis residual allows for

measurement of a very significant stock effect which was classified as convenience yield for the July model.

Measuring Convenience Yield and Risk Premium

The use of the FOB bulk price in defining the basis residual results in stocks having a stronger impact on the basis residual and led to an alternative definition of convenience yield and risk premium.

Review of the Concepts

Convenience yield and risk premium are two distinct theoretical concepts used to explain basis variations. The concepts are distinct in that the arguments used to explain their existence can be logically separated and understood in isolation. Unfortunately, the theoretical distinction does not imply an unambiguous statistical distinction.

Traditionally, convenience yield is theoretically viewed as having a negative impact on the basis for lower stock levels and no impact for high levels. At low levels of storage, stock holders expect and receive a premium in the spot market for allowing inventories to fall below acceptable levels. Rising spot prices reduces the basis and lessens the incentive to forward price.

Increases in stocks result in an increase in the basis according to the traditional risk premium concept. Additional stocks result in stock holders facing more risk from unforeseen future price movements. To compensate stock

holders for incurring this additional risk, the futures price is forced up as is the anticipated price for the future.

Both the convenience yield and risk premium are traditionally viewed as being functions of stocks on hand or inventories held. The traditional view, as presented by Brennan (1958), of the marginal impact of stocks on convenience yield and risk premium and thus the basis was initially reviewed in Figure 2.1.

Ward-Dasse's model and the updated version in the previous chapter allow for stocks below average to have an impact on the basis through a convenience yield variable. Risk premium is viewed as a function of an anticipated level of stocks which is operationalized by use of the current crop forecast. The rationale being that the higher the forecast, then the greater the expected future level of stocks and the greater the potential risk from inaccurate forecasting. Ward-Dasse do not directly allow for stock levels above the norm to impact the basis.

The Alternative Treatment

Since the traditional risk premium and convenience yield concepts are both functions of stocks, it is proposed that for statistical purposes they can best be operationalized with a single variable which is a function of stocks. Such an approach was also used by Brennan (1958). The stock variable replaces the convenience yield variable in the

models estimated in this chapter. The Ward-Dasse concept of an anticipatory risk premium effect based on the crop forecast is retained. It is relabeled as an anticipatory risk premium to distinguish it from the more traditional risk premium concept which is embodied in the stock variable.

Various functional forms for the stock variable were considered. The decision as to the form selected was based on both theory and the statistical results. The traditional view of the risk premium and convenience yield curves, reviewed in Figure 2.1, yields a stock curve such as the one in Figure 7.1 which is merely a summing of the convenience yield and risk premium curves. The stock curve or stock effect is only one determinant of the basis residual as noted below:

(7.1) basis residual = SE{t} + CE{t}

where

SE{t} = the stock effect in period t (which is a function of stocks or inventories),

CE{t} = other effects in period t.

A stock curve, such as that in Figure 7.1, could be approximated by using a third degree polynomial and specified as

(7.2) $SE\{t\} = \phi\{0\} + \phi\{1\}(\ S\{t\}\ ) + \phi\{2\}(\ S\{t\}^2\ ) + \phi\{3\}(\ S\{t\}^3\ )$

where

S{t} = relative stocks (actual variable used is an index that weights the current number of

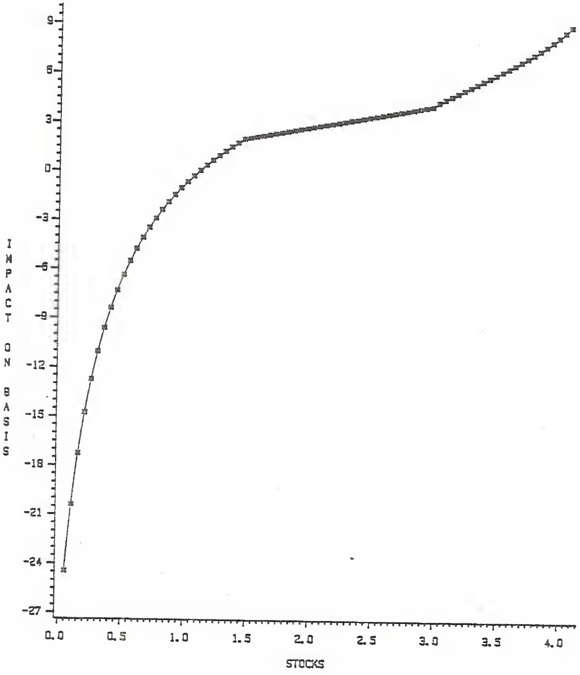

Figure 7.1. Traditional view of the impact of stocks on the basis

weeks of supplies on hand by the corresponding average value for the data for the current week of the season - reviewed in the previous chapter. This index removes seasonal variation and allows for the ramifications of an expanding market),

$\phi\{0\}$ = constant effect coefficient,

$\phi\{1\}$, $\phi\{2\}$, $\phi\{3\}$ = coefficients to be estimated.

To yield the desired general shape $\phi\{1\}$ would have to be positive, $\phi\{2\}$ negative, $\phi\{3\}$ positive and the constant effect negative.

Specifications using an inverse of relative stocks and the natural log of relative stocks yielded more meaningful results (the inverse of stocks is simply one divided by S{t}). A comparison of actual results using these specifications is presented in Figure 7.2. The curves plotted are based on the following equations:

(7.3) log curve: SI{t} = 1.7165 + 14.0386log(S{t})

inverse curve: SI{t} = 14.8464 - 12.8073(1/S{t}).

A constant effect, or intercept effect, is implied in measuring the influence of stocks and is included in the comparison. Note that the log coefficient is positive and the inverse coefficient is negative as would be hypothesized.

Examination of the plots over the range of the stock index encountered for the data period (S{t} has a minimum value of 0.5609 and a maximum value of 1.4013) does not reveal a marked difference in the two alternative curves. Both yield similar results, hence no clear statistical

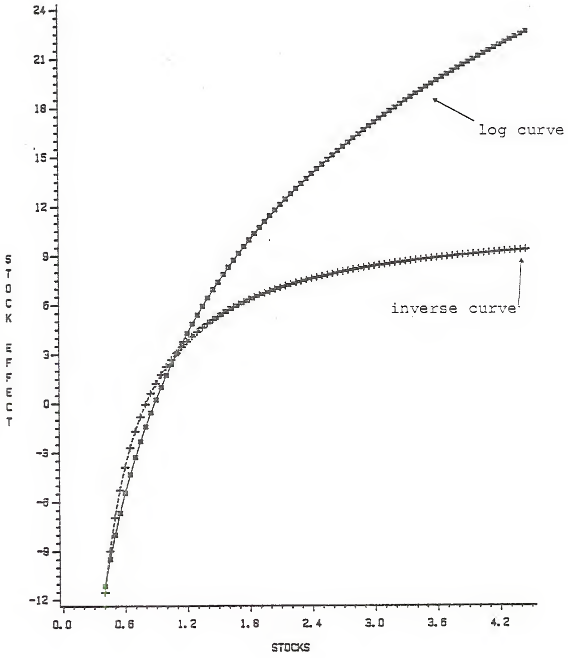

Figure 7.2. Comparison of log and inverse stock curves

advantage of one over the other is evident except when using the models for analysis in ranges beyond the data values. The final decision on the specification to use was based on theoretical grounds. Though, admittedly, arguments can be made for either specification.

The main argument to be cited for the log treatment is that it allows for the impact of stocks on the basis to continuously increase as very high levels of stocks are reached. At extremely high levels of stock the inverse model will result in additional stocks having virtually no impact; the inverse of relative stocks will approach zero and the total effect will approach the value of the constant effect. The log curve is more similar to the Brennan(1958) example, which is reviewed in Figure 7.1, in that it continues to increase at very large stock levels.

The logic used by Brennan (1958) and other authors for a possible extremely rapid acceleration in marginal risk premium at high levels of stocks is that the potential risk associated with unforeseen price movements is so great in this range that the carrying of additional stocks jeopardizes the future financial well being of the firm. To induce carrying of such stocks the expected futures price and the futures market price must increase relatively rapidly. Arguments can be cited that disagree with this concept. For example, it can be argued that there is some upper bound that limits the extent that the futures price

can be bid up relative to the spot price. At this upper bound, it would become economically feasible for enterprises that traditionally have no storage function to buy spot and store it for future resale. Given this argument, then the inverse function seems more plausible.

One should not view the stock curve depicted in Figure 7.1 as necessarily existing for all commodities. Brennan (1958), after proposing the curve, allows for alternative possibilities in his empirical work. For most commodities, the rapid increase in the risk premium does not occur since stocks never reach a high enough level to create the added risk.

Furthermore, it is questionable whether the logic behind the hypothesis of a rapid acceleration in marginal risk premium is applicable to the FCOJ industry. Relative to most annual crops, orange production in forthcoming seasons is easy to predict. Citrus production is a long term process, making major production changes from year to year less likely. Several years must pass before a newly planted tree can produce marketable fruit. Most variability in production from one year to the next is due to weather conditions, especially freezes. With annual crops, prices may decrease dramatically from one year to the next simply because a relatively large crop is planted. Most hedgers that use the FCOJ futures market place short positions. It could be argued that potential price decreases are weighted

more heavily than potential price increases in determining risk premium levels since for short hedgers or inventory holders a potential price increase is not a risk but desirable. Thus, the potential for freezes would have minimal effect on the risk premium.

The inverse function of stocks was selected rather than the log function. The implied assumption being that after some point, additional stocks do not influence the basis in any appreciable manner. The inverse function is similar to the traditional curve, Figure 7.1, except it does not include a rapid turning upwards at high levels of inventories. Beyond the range of the stock index, which is 0.5609 to 1.4013, the log specification appears unreasonable.

Within this range of the stock index, the inverse function does not yet become flat, that is it is still some distance from its asymptote. Thus, additional stocks in the upper range have a limited but positive impact on the basis. Within this range the inverse and the log functions are very similar. Perhaps the reason they both perform better than a third degree polynomial is that the high level of stocks associated with an acceleration of the traditional stock curve are never reached in the FCOJ industry.

What would actually happen at extremely high inventory levels is questionable. Historical pricing policies in the industry, directed to managing season ending inventories,

imply that such extreme levels of stocks are unlikely. The models in the next section embrace an asymptotic assumption implied by using the inverse of stocks variable. One must be careful when using these models with data extending beyond the historical ranges of the stock levels.

Those that question the validity and the existence of the risk premium concept would perhaps interpret the inverse stock function in a different manner. The inverse function corresponds very closely to the traditional convenience yield curve reviewed in Figure 2.1 and would serve to measure convenience yield if in fact there is no real world counterpart to the risk premium concept. The inverse function will approach zero for high levels of stocks, likewise the traditional convenience yield curve is zero for high stock levels.

Before turning to the estimated models it should be pointed out that the possibility of cutting the stock variable into two separate variables, a low inventory variable (convenience yield dominant) and a high inventory variable (risk premium dominant) was investigated. The rationale being that it could be theoretically possible for the risk premium and convenience yield curves to be moving in different directions over time. Such a possibility would imply a twisting in the inverse stock curve over time. Such a twisting would imply that part of the curve is increasing or moving up over time and part of the curve is decreasing

over time. Rather than attempting to model such twisting, the stock variable was divided, with one stock variable being comprised of high stock levels and the other low stock levels. Various definitions of high and low stocks were considered. The stock level chosen as the breaking point was determined by an iterative procedure that estimated the models using various dividing points and chose the point that minimized the sum of squared errors. No evidence was found to suggest that the two stock variables were moving in opposite directions over time or to be moving in the same direction at different rates.

Model Estimation

The purpose of this section is to present the specification and results of the constant period from maturity models. A number of alternatives to the final specification are reviewed before discussing the final model.

The initial group of estimates presented represent a simple transformation of the July contract model into a constant period from maturity model. Differences in the constant period from maturity models when compared to the July model are noted. To avoid redundancy, a discussion of why variables included in the July model are also included in these constant period models is not included. The same basic theoretical principles are addressed by each specification. Previous discussions in this chapter have

pointed to why the initial specification takes the form that it does.

It should be noted that the results from the July model and the constant period models were not perfectly comparable due in part to the difference in cash prices used in defining the basis residual.

Monthly data were used, while weekly data were used for the July model. The decision to use monthly data was dictated by problems encountered in attempting to obtain time varying parameter estimates. Various computational problems, related primarily to the large number of observations with weekly data, were alleviated by working with monthly data. One would expect that monthly data to be influenced less by temporary, random fluctuations. The ordinary least squares results using monthly data differed very little from those obtained using weekly data.

The estimation strategy was to first obtain an economically meaningful ordinary least squares solution. After this ordinary least squares estimate was obtained, time varying parameter estimates were calculated using a Cooley-Prescott procedure (see Chaper III). No indication of a change in structure over time was suggested by the time varying parameter results. The index of permanent parameter adjustment (θ*) was estimated to be statistically no different from zero. Thus, this section focuses on the structure of the models considered and the ordinary least

squares estimates. The time varying parameter estimates given θ^* equals zero are similar to the ordinary least squares results, but embrace assumptions regarding the covariance structure that are not necessary if $\theta^* = 0$.

Initial Model Specifications

The basic model is discussed in this section. It represents a translation of the July contract model into a constant period from maturity model. The major differences in this model and the July model include the dropping of the time components, converting the convenience yield variable into a stock variable which measures both convenience yield and risk premium, extending the period considered to cover the entire year, and extending the period of the freeze bias definition to include months not included in the original model.

A group of models corresponding to two, three, four, five, and six months away from maturity were estimated with the general form

$$(7.4)\quad BR\{t\} = \theta\{0\} + \theta\{1\}RP\{t\} + \theta\{2\}INVSTK\{t\} + \theta\{3\}ML\{t\} + \theta\{4\}FB\{t\} + \theta\{5\}FZ\{t\} + u\{t\}.$$

where

BR{t} = basis residual (denoted BR{t} for the two months away from maturity model, BR3{t} for the three month, BR4{t} for the four month, BR5{t} for the five month, and BR6{t} for the six month),

$\theta\{0\}$ = constant term (+),

RP{t} = anticipatory risk premium (+),

INVSTK{t} = stock variable measures both convenience yield and risk premium concepts; defined as 1 / (relative inventory level) (-),

ML{t} = market liquidity (denoted as ML2{t} for the two month from maturity model, ML3{t} for the three month, ML4{t} for the four month, ML5{t} for the five month, and ML6{t} for the six month) (+ or -),

FB{t} = Freeze bias (+),

FZ{t} = freeze, number of degrees the freeze was below 28 during a freeze month and zero otherwise (+ or -),

u{t} = error term.

The data period extends from December 1967 to November 1982. The results for this group of models is reviewed in Table 7.1. Table 7.2 reviews the variable definitions completely. Note that the t subscript refers to continuous time for the constant period models and not time away from maturity as it does for the July contract model.

Explanatory variable definitions are similar to those used for the July contract model (see Table 7.2 versus Table 6.5). The same variable notation is used when applicable, though variable definitions are slightly different. The INVSTK{t} variable replaces the CY{t} variable of the July contract model as explained earlier in this chapter. Since the dependent variable for each model in the group represents a virtual constant time from maturity, no time component is included. Here RP{t} is defined as before with the time component removed and is labeled an anticipatory risk premium. The market liquidity variables are based on

Table 7.1. Initial constant period estimates

Variable	Six Month Model	Five Month Model	Four Month Model	Three Month Model	Two Month Model
Constant	21.6604	18.8062	14.8464	11.4483	7.9149
	(5.291) [1]	(4.872)	(4.395)	(2.715)	(3.787)
RP{t}	0.0036	0.0076	0.0175	0.0205	0.0249
	(0.215)	(0.479)	(1.257)	(1.835)	(2.898)
INVSTK{t}	-18.9238	-15.9033	-12.8073	-9.1983	-5.5964
	(-8.80)	(-7.899)	(-7.267)	(-6.515)	(-5.126)
ML{t} [2]	-0.0011	0.0009	-0.0008	0.0022	0.0032
	(-0.047)	(0.0088)	(-0.147)	(0.487)	(1.170)
FB{t}	6.6453	5.0352	3.5109	1.7786	-0.0733
	(3.489)	(2.873)	(2.251)	(1.404)	(-0.075)
FZ{t}	0.3873	0.3005	0.2750	0.1940	0.1611
	(0.839)	(0.703)	(0.726)	(0.629)	(0.2367)
R^2	0.3778	0.3336	0.3109	0.2703	0.2327

[1] t-statistics are in parenthesis.
[2] Market liquidity variable: ML6{t} for the six month model, ML5{t} for the five month, ML4{t} for the four month, ML3{t} for the three month and ML2{t} for the two month.

Table 7.2. Variable definitions for the initial constant period model

Variable	Description

BR{t} = Basis residual.

Denoted BR{t} for the two month model, BR3{t} for the three month, BR4{t} for the four month, BR5{t} for the five month, and BR6{t} or the six month.

BR6{t} is the average for the current month of the weekly six month basis residual variable (br6{t}) which is defined:

br6{t} = b6{t} - m6{t}

where:

b6{t} = basis of contract that is currently closest to being six months away from maturity (cents per pound solid).

m6{t} = storage and interest costs (cents per pound solid).

b6{t} and m6{t} are defined as:

b6{t} = fp{t} - (cp{t} + tc{t})

where:

fp{t} = weekly closing futures price of the contract currently closest to being six months from maturity (cents per pound solid) (Citrus Associates of the N.Y. Cotton Exchange, 1967-82)

cp{t} = derived raw orange price (cents per pound solid) derived by subtracting total processing costs (Hooks and Kilmer, 1967-82) from FOB bulk FCOJ price (Citrus Associates of the N.Y. Cotton Exchange, 1967-82).

tc{t} = cost of converting oranges into bulk FCOJ not including Florida taxes and selling costs (cents per pound solids) (Hooks and Kilmer, 1967-82).

Note: cp{t} + tc{t} is the current Florida bulk FCOJ price minus the costs Florida processors must pay for advertising and other taxes and selling costs.

Table 7.2--continued

Variable	Description

$$m6\{t\} = c\{t\} + (\exp(rw) - 1)(cp\{t\} + tc\{t\})$$

where:

$c\{t\}$ = storage costs of carrying bulk FCOJ the length of time that the current futures contract considered matures (cents per pound solids) (Hooks and Kilmer, 1967-1982).

$\exp(rw) - 1$ = an adjustment for calculting interest on the initial cash outlay of processors. w is weeks until the futures contract considered matures r is the interest rate (Survey of Current Business, 1967-82).

BR5{t}, BR4{t}, BR3{t}, and BR2{t} were calculated in a similar manner as BR6{t}. The difference being that the futures price was based on the contract that is currently closest to the length of time considered by the corresponding model.

INVSTK{t} = 1 / S{t}

where:

S{t} = relative stock level defined: (INV{t} / YRMOV{t}) / (MINV{t} / MYRMOV{t}).

INV{t} = The average inventory held by Florida processors during the current month. Average based on the weekly closing inventory levels during the current month (Florida Canners Association, 1967-82).

YRMOV{t} = Movement of FCOJ by Florida processors during previous twelve months. Calculated as the monthly average of a corresponding weekly variable which was defined as movement in the current week plus movement during the previous 51 weeks (Florida Canners Association, 1967-1982b).

MINV{t} = Average of INV{t} across the data period (December 1967 - November 1982) for the month considered. MINV{t} in January equals the average value of INV{t} during the month of January, etc.

Table 7.2--continued

Variable	Description

MYRMOV{t} = Average of YRMOV{t} across the data period for the month considered. MYRMOV{t} in January equals the average value of YRMOV{t} during the month of January, etc.

Thus, INVSTK{t} is the inverse of current weeks of supplies on handed divided by the average weeks of supplies on hand for the month considered.

FB{t} = Freeze bias variable, defined:

FB{t} = ln((N/11) + 1)

where:

N = 2.0 in October, 8.0 in November, 10.0 in December, 6.0 in January, 2.0 in February, and zero in other months. The definition is a monthly version of that used by Ward-Dasse that is extended to include October and November. N represents the average number of weeks remaining in the freeze period for the months of December, January, and February. In October and November the logic used in choosing N was to have N increase twice as fast as it declines (the peak being the last week of November and the first week of December). The values of FB{t} from October through February were 0.167054, 0.546544, 0.646627, 0.435318, and 0.167054, respectively. FB{t} equaled zero for other months.

FZ{t} = Freeze variable.

FZ{t} is the number of degrees below 28 degrees during the coldest day of the month. Zero in months that have no temperature below 28 degrees. Average based on the locations of Sanford, Clermont, and Mountain Lake all which are in Florida (Florida Crop and Livestock Reporting Service, 1967-82).

ML{t} = Market liquity.

ML{t} is denoted ML2{t} for the two month model, ML3{t} for the three month, ML4{t} for the four month, ML5{t} for the five month, and ML6{t} for the six month.

Table 7.2--continued

Variable	Description

ML6{t} is the average for the current month of the weekly six month market liquidity variable (ml6{t}) which is defined:

$$ml6\{t\} = v\{t\} / |choi\{t\}| \text{ , if } |choi\{t\}| \geq 0$$
$$= 0 \text{ , if } |choi\{t\}| = 0$$

where:

V{t} = Volume of contracts traded on closing trading day of the current week for the contract that is current closest to being six months away from maturity (number of contracts) (Citrus Associates of the N.Y. Cotton Exchange, 1967-1982).

|choi{t}| = Absolute value of the closing open interest this week minus the previous week's closing open interest for the contract that was closest to being six months away from maturity (number of contracts per day) (Citrus Associates of the N.Y. Cotton Exchange, 1967-82).

ML5{t}, ML4{t}, ML3{t}, and ML2{t} were calculated in a similar manner as ML6{t}. The difference being that the contract used is the contract that is currently closest to the length of time considered by the corresponding model

RP{t} = Anticipatory risk premium variable (labeled anticipatory to distinguish it from the more traditional risk premium concept addressed by INVSTK{t}).

RP{t} is the monthly average of the weekly variable (rp{t}) defined:

$$rp\{t\} = sa\{t\}$$

where:

sa{t} = Projected availability of crop for the current season (USDA crop forecast for Florida: million boxes) (Florida Citrus Mutual, 1968-83).

the same definition as ML{t} in the July model with the volume and open interest used in defining them being those of the relevant contract. The freeze variable is a monthly counterpart of the July contract freeze variable. The freeze bias variable, FB{t} , is a monthly version of the weekly July contract freeze bias variable that has been expanded to include the months of October and November. The new version has the bias begin in October, peak in December, and end in February. No freeze bias adjustment variable (FBA{t}) is included in the models estimated in this chapter. For the July contract model, FBA{t} allowed the size of the crop forecast to effect the extent of the total freeze bias. Experience with estimating the July model over such a long data period indicated that the FBA{t} effect is difficult to measure and interpret due to the tendency for the crop forecast to increase over time. If the expected crop size does in reality impact the size of the bias, then the FB{t} coefficient in equation 7.1 should vary accordingly when estimated using time varying parameter procedures.

The above set of models was also estimated using weekly data and also using the cash price of oranges in defining the basis residual. In comparing these results and the July contract results, it was clear that the major source of difference between the results presented above (Table 7.1) and those for the July contract (Table 6.4) was the difference in cash prices employed.

The risk premium and market liquidity effects are similar for the above group of models and the July model. There does not appear to be any major difference in the adjustment in the futures price and the FOB bulk price for FCOJ to a freeze. For the models presented in this chapter, FZ{t} is virtually equal to zero. As it is defined in this chapter, FB{t} assumes the same shape as used for the July contract model for corresponding months. Alternative definitions could be used that would increase the models explanatory power slightly and also increase the freeze bias t statistics as will be clear as additional models are reviewed. The stock effect is stronger for the basis residual defined using the bulk FOB price.

The basic model specified above was respecified and estimated with the goal of increasing its explanatory power. Efforts were concentrated on the July through November period since estimation errors were often relatively large during this period.

This basic model when estimated using time varying parameters did not exhibit a change in parameters over time (the index of permanent parameter adjustment or θ^* equals zero). It appears unreasonable to expect slight changes in specification to lead to a conclusion that parameters do vary since the estimation procedure used is flexible as to the nature of the changes traceable. Other specifications estimated in a time varying parameter framework also showed no evidence of parameter changes.

Allowing for Dynamics and Seasonal Patterns

Since the constant period models encompass the entire year, it was recognized that seasonal factors might be present in addition to those cited by Ward-Dasse. Groups of models using various sets of monthly dummy variables were estimated in an attempt to document any seasonal pattern in basis residual movements. The explanatory power of the estimates increased significantly with these adjustments. The results indicated that the months of July through October tended to have a basis residual value that was below the average. However, when the pattern suggested by the dummy variables was compared to the actual data it was evident that the seasonal patterns were more complex than implied by simple shifting of the intercept. This observation lead to additional model specifications.

Specification and results. Graphing the basis residual over time, Table 4.2, revealed that the dip in the basis residual, which tends to be lowest in September, may be greater towards the beginning of the data period and less towards the end of the data period. The revised specifications attempted to account for any possible change in seasonal patterns over time.

By adding a one year lag of the relevant basis residual to the model (denoted BR2{t-12} for BR{t}, BR{t-12} for BR3{t}, etc.) the possibility of seasonal patterns and dynamics in seasonal patterns could be considered as

described below. More plausible estimates were obtained by also including a one month lag of the basis residual in the model (denoted BR2{t-1}, BR3{t-11},etc.) The results of expanding the basic model, presented in the last section, to include the first and the twelfth lag of the basis residual are reviewed in Table 7.3.

One period lags in the dependent variable. The inclusion of a lagged dependent variable is often desirable when the events occuring during one observation period influence events in the next period. When relatively short observation periods are used, such as weekly or monthly data, lagged dependent variables are often appropriate. This inter-period influence may occur for a number of reasons. Rigidities due to habit persistence or unaccounted for transaction costs may result in the dependent variable not fully adjusting immediately to changes in the independent variables. Variable measurement problems may prevent the precise quantification of the effects of particular variables for in any one period. Inclusion of a lagged dependent variable may lessen these problems by allowing the impact of present events to act beyond the current period (Phlips, 1974).

To aid in interpreting the results of a model with a lagged dependent variable, consider the hypothetical model where E{t} is the dependent variable and I{t} and M{t} are explanatory variables which are not lagged variables. These

Table 7.3. Results for a dynamic version of the initial constant period model

Variable	6 Month Model	5 Month Model	4 Month Model	3 Month Model	2 Month Model
Constant	6.4805	5.5325	5.1200	4.6850	2.8758
	(2.226)[1]	(2.014)	(2.114)	(2.323)	(1.688)
RP{t}	-0.0109	-0.0085	-0.0051	-0.0020	0.0040
	(-0.926)	(-0.760)	(-0.054)	(-0.233)	(0.540)
INVSTK{t}	-4.3679	-3.6134	-3.3485	-3.0483	-1.8293
	(-2.578)	(-2.306)	(-2.433)	(-2.727)	(-1.992)
ML{t}[2]	-0.0099	-0.0063	-0.0052	-0.0013	0.0004
	(-0.706)	(-1.068)	(-1.491)	(-0.421)	(0.187)
FB{t}	6.1126	5.2535	4.3157	3.389	2.2398
	(5.153)	(4.784)	(4.312)	(3.910)	(2.922)
FZ{t}	-0.0119	-0.0585	-0.0124	-0.0393	-0.0145
	(-0.044)	(-0.230)	(-0.054)	(-0.200)	(-0.085)
BR{t-1}	0.7032	0.6638	0.5963	0.5221	0.5066
	(12.783)	(11.629)	(9.939)	(8.270)	(7.697)
BR{t-12}	0.0907	0.1362	0.1772	0.2159	0.1985
	(2.171)	(3.162)	(4.011)	(4.612)	(3.739)
R^2	0.7507	0.7164	0.6702	0.5965	0.5013

[1] t-statistics are in parenthesis.
[2] General notation; specific notation includes the number of months addressed i.e. ML6{t}, BR6{t-1}, BR5{t-1}.

variables can represent almost anything; they are cited only to serve as an example. The fully adjusted or equilibrium or long run value of the dependent variable is denoted B*{t}. The corresponding short run equation measures the impact of the explanatory variables in the current period and can be written

$$(7.5)\quad B\{t\} = \theta\{0\} + \theta\{1\}I\{t\} + \theta\{2\}M\{t\} + \theta\{3\}B\{t-1\} + e\{t\}$$

where θ{0} is a constant term, θ{1}, θ{2}, and θ{3} are coefficients and e{t} is an error term. Events in the current period, acting through the explanatory variables and the error term will determine the value of the current dependent variable and influence dependent variable values in subsequent periods. That is, the value of B{t} will effect the value of B{t+1} since B{t} will be the lagged variable in period t+1. Since B{t+1} impacts B{t+2} and B{t} impacts B{t+1}, B{t} will effect B{t+2} as well. Similarly B{t} and those factors determining B{t} will have an impact in more distant periods. The cumulative impact of the events in period t on B{t} and subsequent B{t+k} values is the long run effect. Alternatively, the long run equation corresponding to period t can be viewed as the eventual, fully adjusted value of B*{t} given that the magnitudes of the explanatory variables excluding the lagged variable do not change from their values in period t.

The long run equation is not directly a function of the lagged variable since the lagged variable will eventually stabilize, allowing the ultimate impacts to be traced to the other variables. The long run equation for this example can be written

$$(7.6)\quad B^*\{t\} = \phi\{0\} + \phi\{1\}I\{t\} + \phi\{2\}M\{t\} + u\{t\}$$

where u{t} is an error term.

The relationship between the short and long run equations can be expressed mathematically. An adjustment process is implied which can be represented as

$$(7.7)\quad B\{t\} - B\{t-1\} = K(B^*\{t\} - B\{t-1\}) , 0<K<1,$$

where K is the adjustment coefficient which measures the tendency for the difference in the long run value or total impact and the lagged value to be reduced in one period. If K equals one, then no adjustment period is needed and all explanatory variables have their full impact in their corresponding observation period. The closer K is to zero, then the greater is the impact of distant past periods on the current period (or equivalently the greater the impact of current values of explanatory variables on future levels of the dependent variable). These relationships are easily seen when equation 7.6 is substituted for B*{t} in equation 7.7 and solved for B{t} yielding

$$(7.8)\quad B\{t\} = K\phi\{0\} + K\phi\{1\}I\{t\} + K\phi\{2\}M\{t\} + (1-K)B\{t-1\} + Ku\{t\}$$

which is the short run estimated relationship equivalent to equation 7.5.

Suppose the following relationship is estimated:

(7.9) $B\{t\} = 1 - 3I\{t\} + .2M\{t\} + .8B\{t-1\}$.

Here K equals one minus the lagged coefficient or 0.2. The corresponding long run equation which measures the long run impact of current explanatory variables on the dependent variable is found by dividing the non-lagged variable coefficients by K and for this example equals

(7.10) $B\{t\} = 5 - 15I\{t\} + 1M\{t\}$.

Many reasons can be cited as to why one would want to consider including a one month lag of the basis residual in the model. The observation period is relatively short, one month, suggesting that rigidities may exist for both the cash and futures markets for FCCJ.

Traders can be expected to maintain their futures position given slight changes in conditions. A trader will not tend to reverse his position immediately but will tend to maintain the position until it can be determined if the change is permanent. Reacting to every turn in the market involves tremendous transaction costs which the trader generally avoids.

There is also reason to suspect rigidities in the FOB price of bulk FCOJ set by processors. There is a tendency to maintain the price even with considerable changes in the industry.

Yearly lags in the dependent variable. By including a yearly lag of the dependent variable it is possible to account for both seasonal patterns and dynamics. Such treatment is especially useful for considering trends in seasonal patterns.

It is possible to interpret this yearly lag in a similar manner as the one period lag. Consider a hypothetical estimated relationship of a monthly model that contains a yearly lag but no other lags, such as depicted below:

(7.11) $B\{t\} = 1 - 3I\{t\} + .2M\{t\} + .8B\{t-12\}$.

Each January B{t} will take on the value of the dependent variable the previous January. Thus, if B{t} tends to be larger in January than the other months, its predicted value will tend to be higher. Developments in one January will impact the next January (and thus future January values - though the impact will dampen over time). An unpredicted change in the seasonal pattern one January will be absorbed by the error term that period but influence the next January's predicted value via B{t-12}. Events in months other than January will not directly influence predicted January values.

The adjustment coefficient associated with equation 7.11 equals 0.2. The corresponding long run model is

(7.12) $B^*\{t\} = 5 - 15I\{t\} + M\{t\}$.

It is perhaps best to conceptualize a different long run equation for each month. That is, a change in I{t} of one

during January, for example, will result in an impact of three during the current month and a long run impact of 15. This long run impact will only be manifested in January months and will not influence other months.

<u>Yearly and one period lags in the dependent variable</u>. When both the first lag and the yearly lag are included in a model, as done in Table 7.3, both long run effects can be added together. The inclusion of the first lag has the effect of dispersing the impact of the yearly lag to all subsequent months after one year has passed. Consider the hypothetical estimated relationship:

(7.13) $B\{t\} = 1 - 3I\{t\} + .2M\{t\} + .7B\{t-1\} + .1\ B\{t-12\}$.

The total adjustment coefficient for a model of this type is found by adding the lagged coefficients together and subtracting the result from one. For this example the total adjustment coefficient equals 0.2 (1-.7-.1). The long run model addresses a $B^*\{t\}$ value that has no seasonal component and is useful only for determining the long run impact of changes in explanatory variables. Though nearby periods falling in the same month as t (such as t+12, t+24, and t+36) will be influenced more by the value of $B\{t\}$ than other comparable nearby periods. For example, the impact of B will be greater in t+12 than t+13 and greater in t+24 than t+25, allowing for trends in the monthly shifts. The long run equation associated with equation 7.11 is found by dividing the short run coefficient by the total adjustment coefficient (0.2) and equals

(7.14) $B^*\{t\} = 5 - 15I\{t\} + M\{t\}$.

The sum of the lagged coefficients is assumed to be no greater than one.

Other variations of the basic model. The general model estimated in this section is a simple example of an ARMA model. More complex ARMA models were also estimated, allowing for different treatment of lagged variables and estimation errors. The one presented was selected for discussion due to its simplicity and because its results and implications were representative.

Twelfth difference models were also estimated. In a twelfth difference model all variables, including the dependent variables, are defined as their current value minus their value 12 months ago. In other words, the yearly change in variable values is used in estimation. The constant term in such a model is interpreted as the tendency for the basis residual to change from one period to the next. The differencing accounts for seasonal patterns. The noteworthy result of employing the differencing approach was that the constant term was found to be virtually zero, implying no trend in the basis residual over the data period.

Comparing the predicted values of the various models discussed in this section to the actual, observed values causes one to question the dynamic and seasonal assumptions made. Though there is an improvement in explaining seasonal

variations when compared to the initial estimates, these models did not perform well during certain seasons when seasonal fluctuations were accentuated. The implication being that while seasonal fluctuations tend to vary from year to year, there does not appear to be a clear pattern or trend to the changes in fluctuations over time.

The Final or Adopted Model

Graphs of basis patterns (Table 4.2) and examination of estimation errors pointed towards the existence of seasonal basis patterns in addition to the freeze bias that are not fully accounted for by the previous models discussed in this chapter. The nature of the fluctuations over time pointed toward drawbacks in each modeling approach considered thus far.

Accounting for seasonal differences. Examination of basis movements (Table 4.2) reveals that the residual for the period running from approximately July to October tends to be lower than surrounding months. This dip in the basis residual can vary considerably from year to year.

The relevant question appeared to be what does theory offer to explain such variance in seasonal basis patterns. In addition to storage costs, storage theory attempts to explain basis movements with the convenience yield and risk premium concepts both of which are functions of stocks. Stocks or inventories are viewed as the key determinants of

the basis. Thus, it appears logical to suspect stocks to influence seasonal basis patterns. Review of the data reveals that the dip in the basis residual tends to be greater when relative stock levels are low. When stocks are extremely high, the dip in the residual is small or not perceptible.

To understand why the impact of stocks may vary for different times of the year, it is important to realize the key role that the anticipated season ending inventory level plays in the setting of industry prices throughout the season. Prices are generally set with the goal of having a carryover of about three months supplies. For the FCOJ industry it is probably more accurate to view convenience yield and risk premium (INVSTK{t}) as being a function of anticipated season ending inventory rather than actual current inventory. By considering the number of weeks of supplies on hand and the time of the season the INVSTK{t} variable does give a good indication as to whether season ending inventories will be high or low. The variable does, however, have its limitations. Other factors involved include the expected crop size, import and export commitments, advertising plans, and projected sales.

The level of certainty as to projected season ending inventories will tend to increase as the season progresses. Very little, if any, crop is harvested from mid-July until the first of December, which marks the start of a new

season. Therefore, during this period it is relatively easy to accurately predict inventory levels. Earlier in the year a greater degree of uncertainty exists.

It appears reasonable to suspect that the basis residual will tend to be more sensitive to relative inventory levels towards the end of the season. A greater degree of statistical sensitivity implies that relative inventory levels will tend to serve as a better predictor of the basis residual; the significance of the relationship should be stronger. Earlier in the season, many other factors in addition to inventories must be considered to gauge season ending inventories.

Increased certainty during the season ending period implies that the risk premium should be less for any given level of stocks. Thus, expected future prices and the basis residual should tend to be lower (if the freeze bias effect is not considered). In terms of the initial model presented in this chaper, increased certainty would imply that the INVSTK{t} coefficient should steadily become more negative towards the season's end.

It is also possible that the convenience yield effect will be stronger. Having less flexibility during this period where little fruit is being harvested, processors may be more likely to raise current prices relative to prices in the future in order to meet inventory objectives. Also, the convenience yield effect may be stronger simply because the

season is drawing to an end, allowing little time to meet season ending carryover objectives.

It is also reasonable to hypothesize that the level of stocks will influence the extent of the freeze bias. The greater the level of stocks, the less the potential impact of a freeze on prices and thus the less the freeze bias. Thus, the INVSTK{t} coefficient will tend to be less negative during the winter months. Since the freeze bias period begins sometime before the on set of winter, one would expect the ending months of the season to be influenced by both the freeze bias and the end of season effect. Thus, it appears likely that the INVSTK{t} coefficient will tend to decrease through summer and eventually begin to increase, continuing to increase until winter. October is a reasonable month to expect the INVSTK{t} coefficient to begin increasing due to the freeze bias effect since at this time most contracts considered by this study will be maturing during or past the freeze period. Though the official season begins in December, October traditionally is the period when widespread attention is given to the next season (since this is the first period when the crop forecast for the forthcoming season is released).

Model specification and results. To account for the hypothesized influence of stocks on seasonal basis patterns, a set of monthly dummy variables were interacted with the INVSTK{t} variable. The January variable was defined as

(7.15) DSTK1 = (D1) (INVSTK{t})

where

DSTK1 = January inverse stock variable,

D1 = a dummy variable that equals one in January and zero otherwise,

INVSTK{t} = 1/S{t}, where S{t} is the relative level of stocks for the current month (Table 7.2 provides a more complete definition).

The corresponding variable for each month is denoted by numbering it according to where it falls in the year. For example, in February the variable DSTK2 equals INVSTK{t} and DSTK2 equals zero during other months. In December the corresponding variable is DSTK12. May was selected as the base period.

The DSTK variables serve to explain seasonal basis patterns via normalized inventories. The freeze bias and the other seasonal factors will influence the DSTK coefficients. A specific freeze bias variable is not included in the model. The general form of the model is

$$(7.16)\quad BR\{t\} = \theta\{0\} + \theta\{1\}BE\{t\} + \theta\{2\}ML\{t\} + \theta\{3\}FZ\{t\} + \theta\{4\}BR\{t-1\} + \theta\{5\}INVSTK\{t\} + \theta\{6\}DSTK12 + \theta\{7\}DSTK1 + \theta\{8\}DSTK2 + \theta\{9\}DSTK3 + \theta\{10\}DSTK4 + \theta\{11\}DSTK6 + \theta\{12\}DSTK7 + \theta\{13\}DSTK8 + \theta\{14\}DSTK9 + \theta\{15\}DSTK10 + \theta\{16\}DSTK11 + u\{t\}.$$

Variable definitions are reviewed in Table 7.2. The DSTK variables are defined above. Note that BR{t-1} is the lagged value of the basis residual, BR{t} (BR{t} is denoted BR2{t} for the two month from maturity model, BR3{t} for the three month, etc.; similarly, ML{t} is denoted ML2{t} for the two month model, etc.). One period is lost due to lagging. The estimation period runs from January 1968 to November 1982. The results are presented in Table 7.4. Variable means and standard deviations are in Table 7.5. The observed and predicted values over the data period are illustrated in Figures 7.3 through 7.7. Time varying parameter estimates suggest no change in parameters over time. Appendix A reviews the time varying parameter results for the four month model. Appendix B contains the corresponding covariance matrices for the estimates reviewed in Table 7.4.

Note that no May inverse stock variable (DSTK5) was included in the models. To aid in interpretation view θ{5} as measuring the May stock effect. The DSTK variable coefficient when added to θ{5} measures the total stock effect for the corresponding month. May was selected as the base month because it serves as a good reference point, falling between the bidding up of the basis in winter and the dip in summer. The DSTK variable coefficients provide a reference as to the relative impact of inventories during the corresponding month. Caution should be used in

Table 7.4. Results for the final version of the constant period model.

Variable	6 Month Model	5 Month Model	4 Month Model	3 Month Model	2 Month Model
Constant	5.7800 (2.20)[1]	4.7064 (1.85)	3.3691 (1.50)	3.1689 (1.64)	2.3842 (1.49)
RP{t}	0.0016 (0.17)	0.0047 (0.51)	0.0099 (1.16)	0.0121 (1.61)	0.0153 (2.02)
ML{t}[2]	-0.0021 (-0.15)	-0.0007 (-0.11)	-0.0042 (-1.87)	-0.0013 (-0.40)	-0.0025 (-1.25)
FZ{t}	-0.0582 (-0.20)	-0.0991 (-0.37)	-0.0686 (-0.25)	-0.1217 (-0.56)	-0.0823 (-0.44)
BR{t-1}	0.7565 (14.48)	0.7380 (13.27)	0.7101 (12.17)	0.6401 (10.15)	0.5708 (8.736)
INVSTK{t}	-4.8484 (-2.84)	-3.9531 (-2.49)	-2.730 (-1.90)	-2.436 (-2.04)	-1.7883 (-1.84)
DSTK12	4.3202 (3.95)	3.8340 (3.71)	2.9687 (3.13)	2.4790 (2.90)	1.9874 (2.71)
DSTK1	1.3464 (1.15)	1.1586 (1.06)	0.7176 (0.72)	0.7458 (0.80)	0.4685 (0.62)
DSTK2	0.3734 (0.34)	0.5075 (0.50)	0.1821 (0.19)	0.3263 (0.38)	0.2046 (0.29)
DSTK3	-0.1939 (-0.18)	-0.4952 (-0.48)	-0.9017 (-0.96)	-0.7762 (-0.93)	-0.1934 (-0.27)
DSTK4	-0.3721 (-0.35)	0.2219 (0.22)	-0.1130 (-0.12)	-0.0326 (-0.04)	-0.0818 (-0.12)
DSTK6	-2.2676 (-2.05)	-1.1991 (-1.15)	-1.4643 (-1.52)	-0.5492 (-0.64)	-0.4413 (-0.62)
DSTK7	-2.4834 (-2.23)	-2.6747 (-2.48)	-1.5749 (-1.63)	-1.2532 (-1.49)	-0.1748 (-0.25)
DSTK8	-2.5034 (-2.25)	-3.4680 (-3.31)	-3.3565 (-3.54)	-2.0946 (-2.50)	-1.3515 (-1.91)
DSTK9	-2.1869 (-1.91)	-2.4206 (-2.20)	-4.0768 (-4.13)	-3.9575 (-4.61)	-2.3927 (-3.34)
DSTK10	1.4395 (1.26)	0.9073 (0.83)	0.1885 (0.18)	-1.1845 (-1.32)	-1.5660 (-2.14)
DSTK11	1.5603 (1.45)	1.1489 (1.11)	0.4301 (0.45)	-0.0566 (-0.07)	-1.1968 (-1.61)
R^2	0.8203	0.8010	0.7802	0.7222	0.6442
h statistic	3.40	3.63	1.68	0.11	-1.20

[1] t-statistics are in parenthesis.
[2]General notation; specific notation includes the number of months that the model addresses: MI6{t}, BR6{t-1}, ML5{t}, BR5{t-1}, etc.

Table 7.5. Variable means and standard deviations for the constant period model

Variable	Description	Mean	Standard Deviation
BR2{t}	Two month basis residual	6.2249	3.2777
BR3{t}	Three month basis residual	5.5415	4.3858
BR4{t}	Four month basis residual	4.8483	5.5380
BR5{t}	Five month basis residual	4.2288	6.3562
BR6{t]	Six month basis residual	3.5059	7.1092
INVSTK{t}	Inverse of relative stocks: 1/(weeks of supplies on hand weighted by average weeks of supplies on hand for the month considered)	1.0495	0.2172
FZ{t}	Freeze variable (degrees below 28 degrees at coldest point in month)	0.1783	0.9515
ML2{t}	Two month market liquidity	31.3461	82.6414
ML3{t}	Three month market liquidity	31.6791	61.7724
ML4{t}	Four month market liquidity	26.7006	62.8753
ML5{t}	Five month market liquidity	20.8654	41.5814
ML6{t}	Six month market liquidity	16.9735	18.8220
RP{t}	Anticipatory risk premium (crop forecast: millions of boxes	164.3688	27.1193

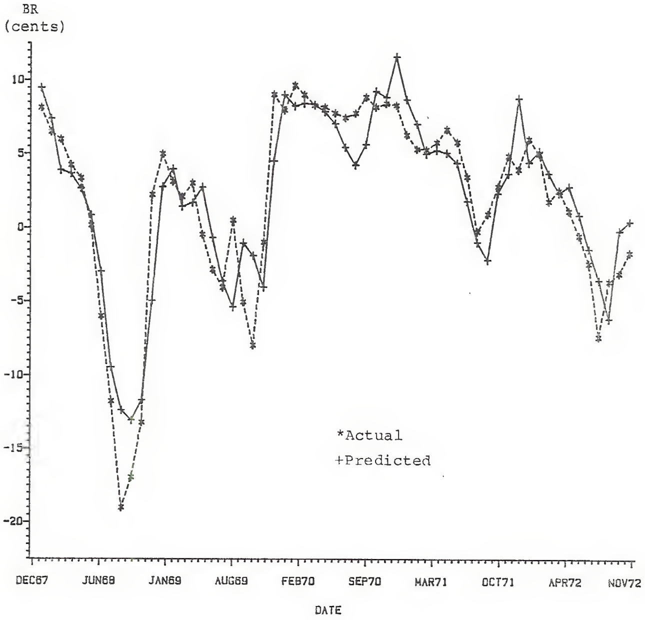

Figure 7.3. Predicted and actual basis residual values for the six month model

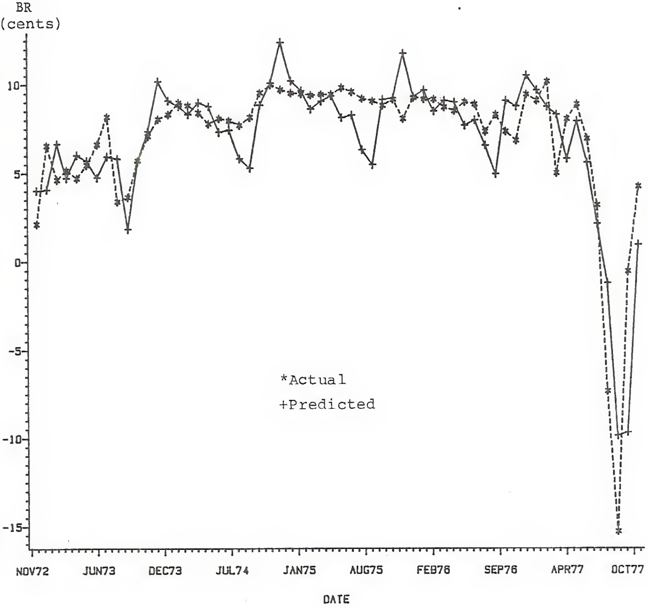

Figure 7.3--continued

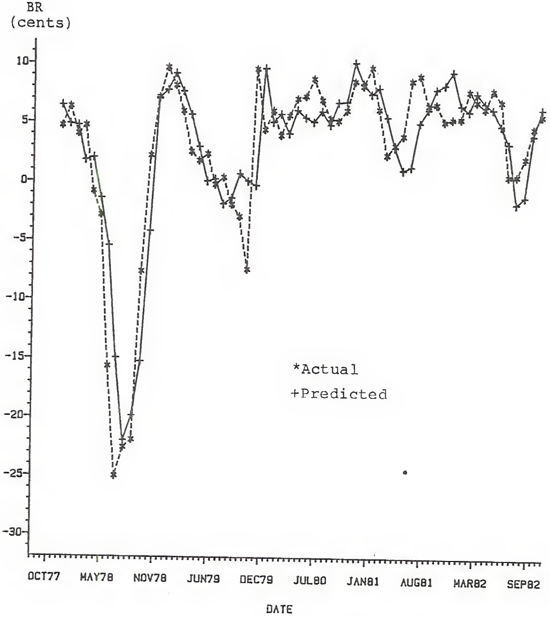

Figure 7.3--continued

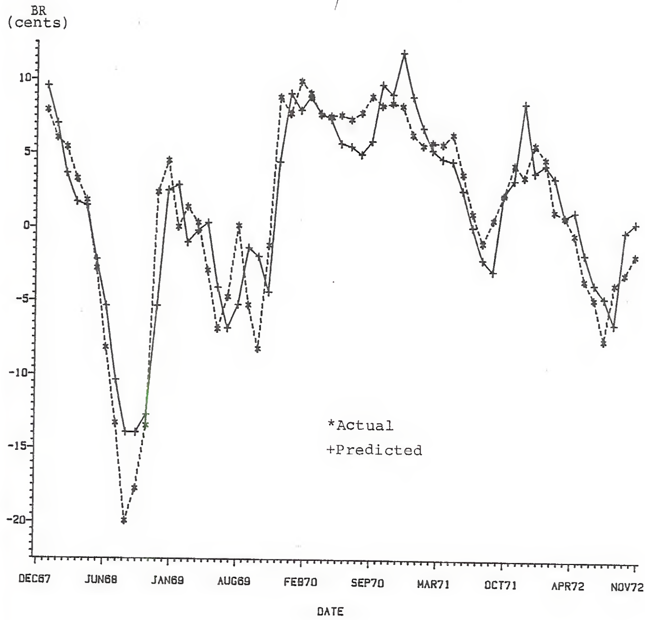

Figure 7.4. Predicted and actual basis residual values for the five month model

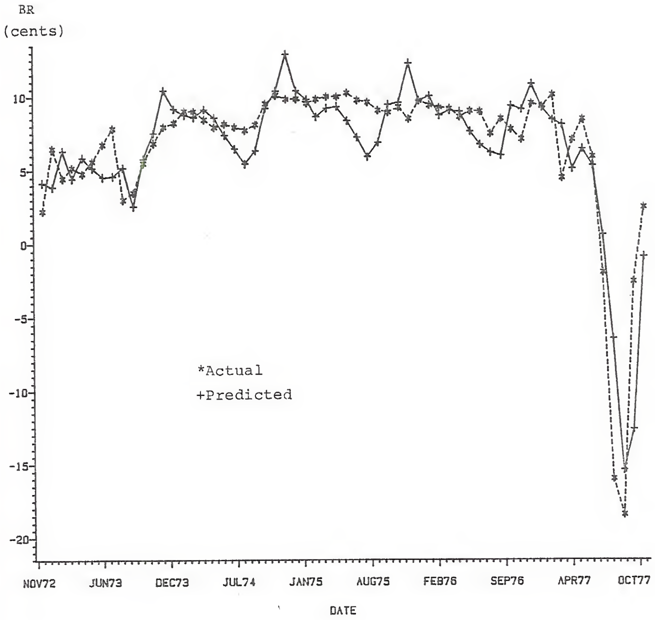

Figure 7.4--continued

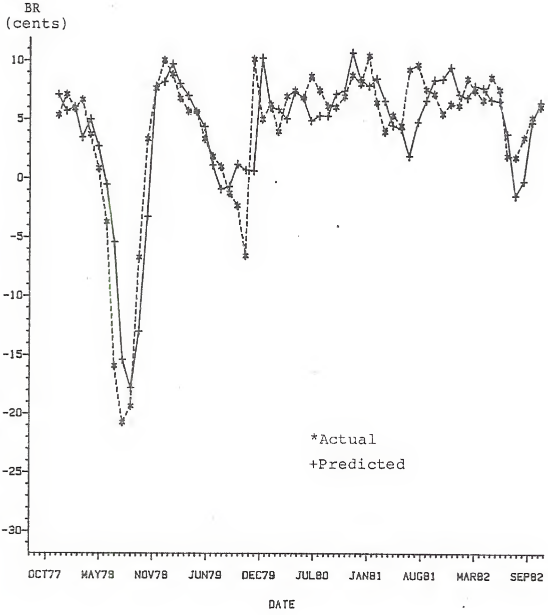

Figure 7.4--continued

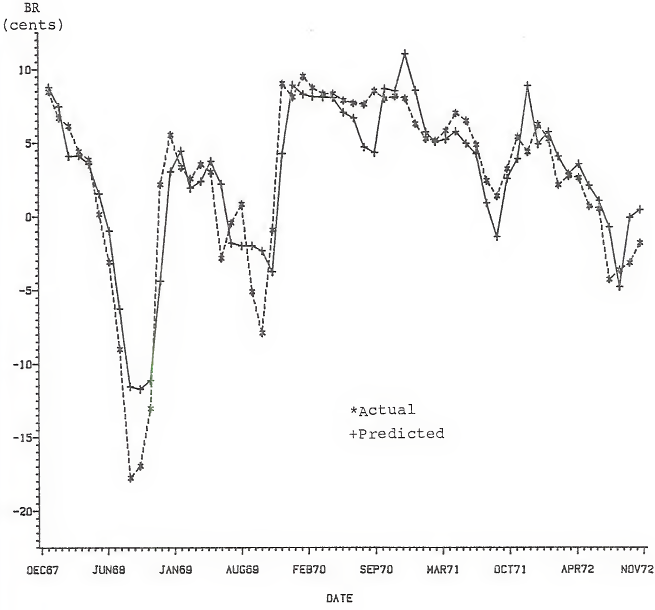

Figure 7.5. Predicted and actual basis residual values for the four month model

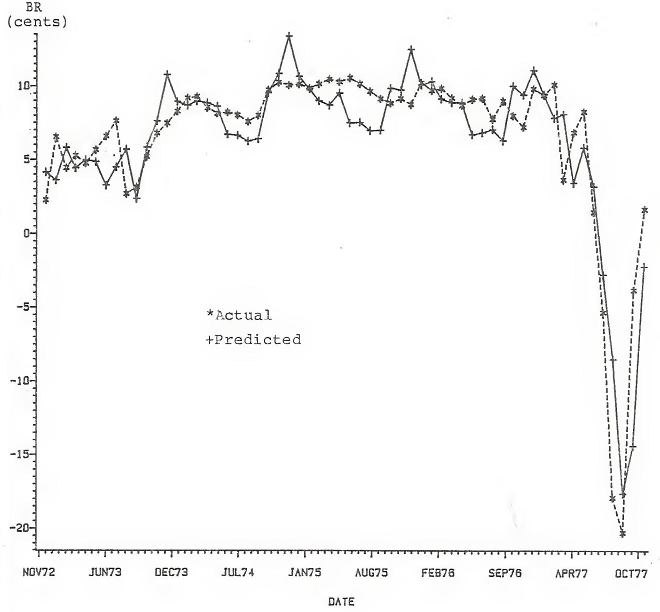

Figure 7.5--continued

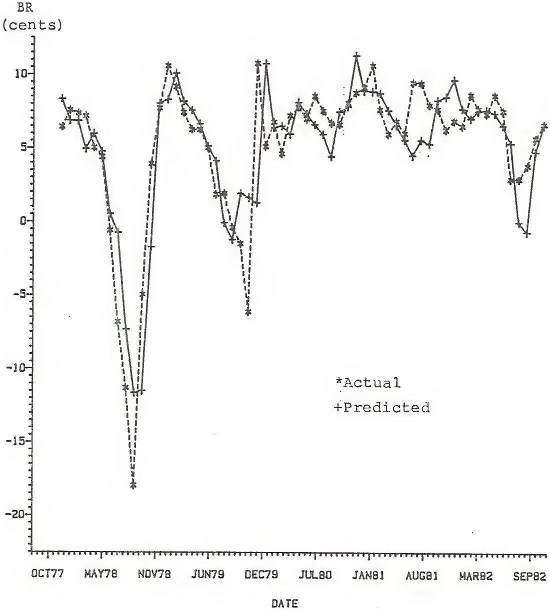

Figure 7.5--continued

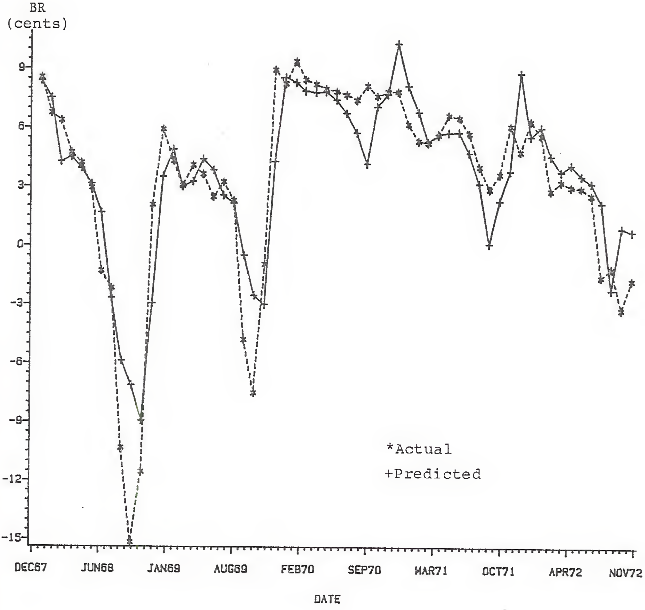

Figure 7.6. Predicted and actual basis residual values for the three month model

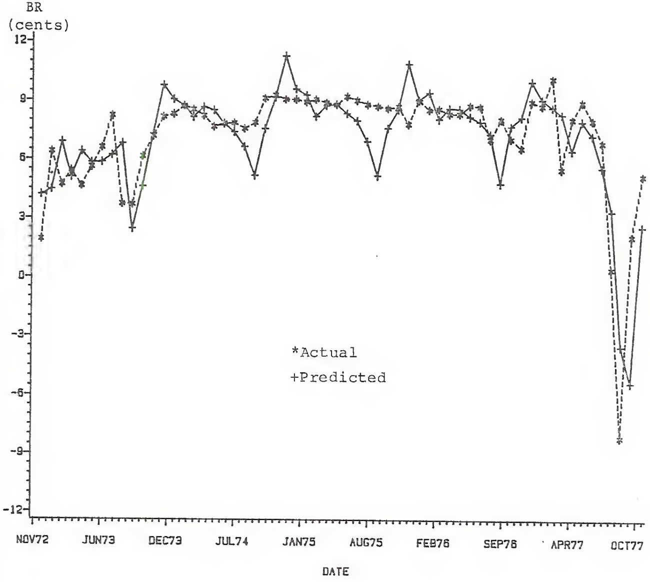

Figure 7.6--continued

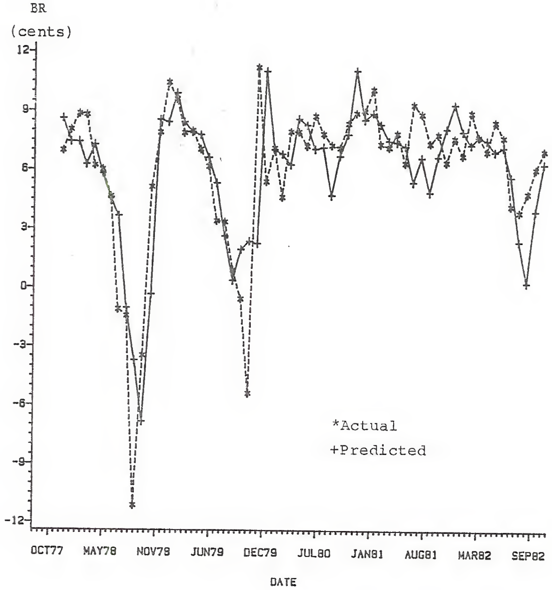

Figure 7.6--continued

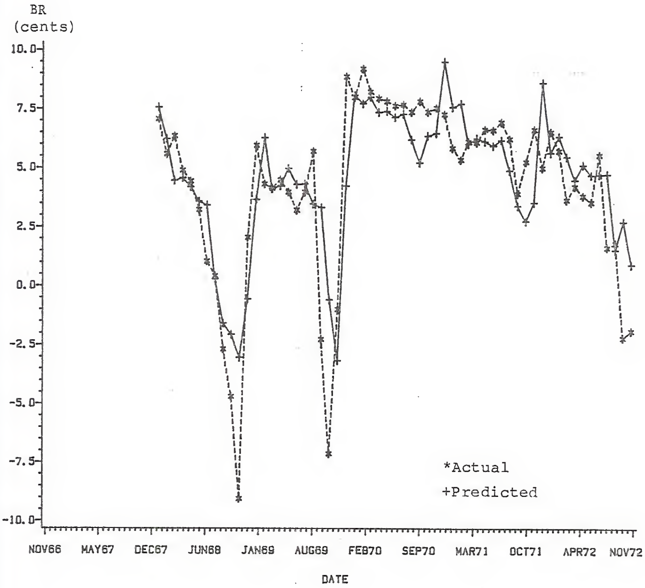

Figure 7.7. Predicted and actual basis residual values for the two month model

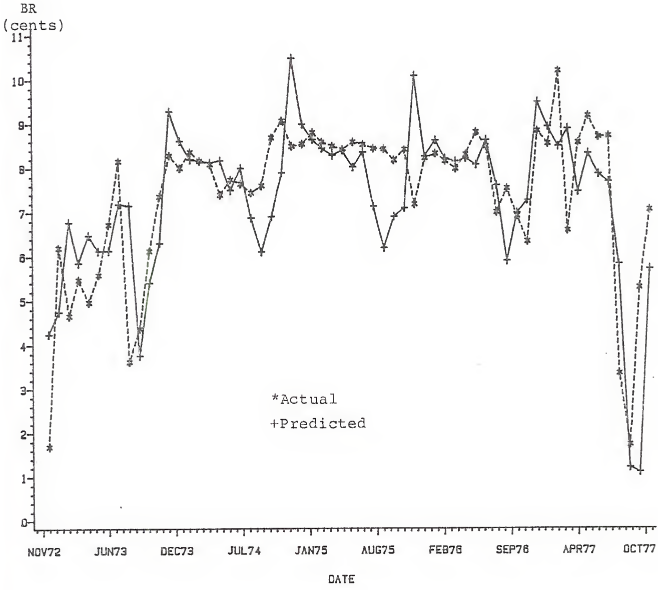

Figure 7.7--continued

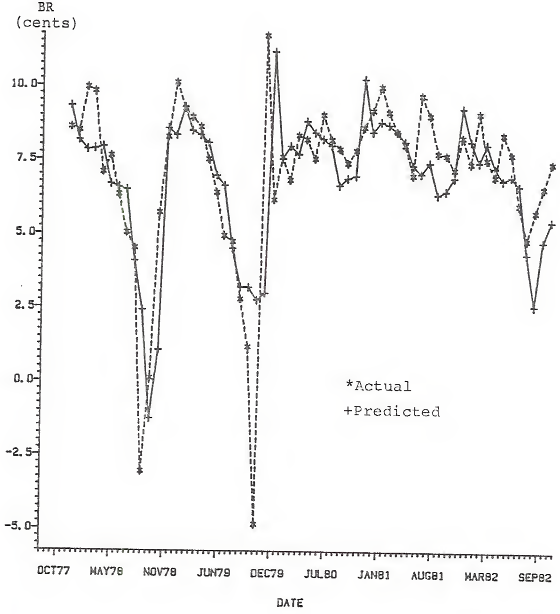

Figure 7.7--continued

attempting to determine seasonal patterns because of the inclusion of the lagged dependent variable. Seasonal patterns are discussed in the next chapter.

If INVSTK{t} is dropped from the model and DSTK5 added, then the resulting model is equivalent to the general model above. The situation is analogous to having the choice of including 11 monthly dummy variables or including 12 and dropping the intercept.

Alternative Specifications.

Other model specifications were also considered. Most specifications discussed in this section are more complex versions of the final model.

It was realized that defining INVSTK{t} and the DSTK variables based on the inverse of relative stocks implied a somewhat arbitrarily set impact of changes in stocks in that alternative definitions could also be used. An alternative and less restrictive approach would be the use of a similar set of variables based on A which would be defined as

(7.17) A{t} = (1/(S{t}))**(a*) , where a*>0 .

Then in May

(7.18) @(A{t}) / @(S{t}) = -a* / (S{t}**(a*+1)).

If the estimated coefficient for A equals ø then in May

(7.18) @(BR{t}) / @(S{t}) = -øa* / (S{t}**(a*+1)).

An optimal value of a* could be found by letting it vary across estimates and selecting the value that minimized the

sum of squared errors. A less restrictive approach would to let a* vary across months.

Both approaches were considered. To decrease the number of iterations needed to find an optimal a* or set of a*'s estimates were made allowing for rather large jumps in a*. Major differences in the sum of squared errors were not noted. Additional iterations with smaller jumps in a* were not made because it was clear that the optimal levels would not provide much more insight than using the simple inverse (Table 7.4). If one value of a* was selected for the entire year, then it would differ according to the length of time to maturity considered. Allowing a* to vary from month to month resulted in differences across the year and across models that were not easily explained. Interpretation of the results for either approach would be difficult and complex. Using the inverse of S{t} is readily interpretable and the resulting pattern of estimated coefficients can be explained theoretically. It was recognized that having only 15 observations for each month could make identification of monthly differences difficult.

Another specification considered was to add the variable BR{t-12} to the final model (Table 7.4). Including the yearly lag increases the complexity of the model and makes interpretation that much more difficult with little apparent gain.

Inclusion of a yearly lag would imply trends in the monthly effects over time. Reviewing seasonal basis patterns, Table 4.2, reveals some trends. However, these trends appear more a matter of chance. The BB{t-12} variable is probably significant due to the history of freezes. During the middle of the data period several years passed with no freezes and as a result relative inventory levels did not vary much. Freezes of varying degrees occur towards the beginning and end of the data period and relative inventory levels vary more. The freeze bias and the end of season dip in the basis appear somewhat dampened during the middle of the data period. If freezes were spread more evenly across the data period it is expected that the B{t-12} coefficient would be insignificant. Obviously, if the final model was perfectly specified, the pattern of freezes would have no bearing. Attempting to model more complex seasonal patterns was hampered by the relatively few observations for each month discussed above.

The possibility of allowing for seasonal patterns via interacting S{t} with a cyclical function, such as a sine function, was also considered. In this way the number of explanatory variables could be decreased. The least restrictive approach would be to translate the results obtained using the monthly inverse stock variables into a function that varies as suggested by the parameters in Table 7.4. Given that no particular problems with degrees of

freedom exists, the form of the model shown in Table 7.4 was selected. It is the least restrictive and easy to interpret.

To gain insight into what a lagged dependent variable is actually measuring, it is often useful to inspect the results obtained by excluding it from the model. Thus, Table 7.6 is included. Shown are the results obtained by dropping BR{t-1} from the final model (Table 7.4). The exact same data period is used for both versions. The estimated coefficients in Table 7.6 tend to be larger in absolute value when compared those in Table 7.4. Thus, dropping the lagged basis residual results in the impact of the other explanatory variables being overstated.

In the next chapter the results are interpreted. Interpretation focuses on the model presented in Table 7.4 though other models are cited when they add to the interpretation.

Table 7.6. Results for a non-dynamic version of the final model

Variable	6 Month Model	5 Month Model	4 Month Model	3 Month Model	2 Month Model
Constant	22.2227 (6.202)	19.2449 (5.833)	14.0362 (4.907)	10.1188 (4.389)	6.3512 (3.425)
RP{t}	0.0105 (0.719)	0.0130 (0.976)	0.0256 (2.215)	0.0285 (3.038)	0.0318 (4.227)
ML{t}	-0.0106 (-0.517)	0.0054 (0.640)	-0.0024 (-0.497)	-0.0011 (-0.270)	0.0047 (1.915)
FZ{t}	-0.1917 (-0.445)	-0.2367 (-0.612)	-0.2344 (-0.640)	-0.2514 (-0.901)	-0.1793 (-0.801)
INVSTK{t}	-18.0811 (-8.315)	-14.7712 (-7.531)	-10.9055 (-6.380)	-7.4384 (-5.354)	-4.3215 (-3.863)
DSTK12	3.2679 (1.984)	1.9714 (1.338)	1.0188 (0.789)	0.5785 (0.544)	0.2500 (0.293)
DSTK1	3.2260 (1.843)	2.1871 (1.390)	1.5355 (1.113)	1.2570 (1.109)	0.6954 (0.763)
DSTK2	2.2629 (1.382)	1.6276 (1.109)	1.0920 (0.844)	0.9896 (0.415)	0.4442 (0.402)
DSTK3	1.3436 (0.820)	0.5432 (0.370)	0.0113 (0.009)	-0.0330 (-0.031)	0.2548 (0.300)
DSTK4	0.8243 (0.509)	0.6576 (0.453)	0.1858 (0.146)	0.1281 (0.122)	0.1327 (0.158)
DSTK6	-2.6558 (-1.591)	-1.7131 (-1.149)	-1.6248 (-1.221)	-0.5972 (-0.545)	-0.4762 (-0.554)
DSTK7	-4.8248 (-2.904)	-4.3685 (-2.836)	-2.7928 (-2.102)	-1.6132 (-1.500)	-0.4436 (-0.514)
DSTK8	-5.9806 (-3.644)	-6.4830 (-4.396)	-5.1134 (-3.956)	-2.9452 (-2.768)	-1.5218 (-1.783)
DSTK9	-7.1969 (-4.358)	-7.6006 (-5.138)	-7.7438 (-5.968)	-5.8465 (-5.478)	-3.3030 (-3.857)
DSTK10	-3.7710 (-2.312)	-4.5753 (-3.131)	-4.9894 (-3.889)	-4.7423 (-4.487)	-3.4657 (-4.100)
DSTK11	-1.0007 (-0.622)	-2.0672 (-1.431)	-2.7597 (-2.179)	-2.8911 (-2.774)	-3.2371 (-3.798)
R^2	0.5878	0.5847	0.5792	0.5457	0.4760

CHAPTER VIII

INTERPRETATION OF RESULTS OF THE CONSTANT PERIOD MODELS

In this chapter the results of the constant period models are interpreted. The interpretation of the constant period models estimated deals primarily with what has been referred to as the final or adopted model set depicted by equation 7.16 and Table 7.4. Of the specifications reviewed it appears that those in Table 7.4 best portrays constant period, FCOJ basis movements. Unless stated otherwise it is assumed that this model is being addressed.

General Discussion

The effect of all variables on the basis residual except stocks are discussed in this section along with other interpretations of the results (Table 7.4). These variables play a minor role in determining basis residual values when compared to stocks.

Performance

Estimates further from maturity perform better in predicting the basis residual. The R^2 is also higher the further from maturity considered although one cannot directly compare these R^2's.

It appears that for the more distant contracts, trading is more reflective of market fundamentals. As maturity approaches traders are often forced to reverse their positions regardless of market conditions and prices in order to avoid holding a commitment when the contract matures. In such case, delivery would have to occur if the positions were not reversed.

Lagged Basis Residual Variables

The coefficient of the lagged dependent variable increases as the time from maturity increases (Table 7.4). The estimated coefficients for the two through the six month models are 0.5708, 0.6401, 0.7101, 0.738, and 0.7565, respectively. The implication being that there is more rigidity in the basis residual further from contract maturity. Thus, futures prices further from maturity will tend to react less quickly to changes in market conditions when comparing the initial to the total impact of a change in conditions (since the cash price used in calculating the residual is the same for each estimate, differences in adjustments will be primarily due to futures prices).

As the length of time from maturity increases the lagged coefficient increases at a decreasing rate and appears to be approaching a limit. Though the speed of reaction to changed conditions is quicker for closer to maturity contracts, it is unlikely that there is much of a difference in contracts more than six months from maturity.

Anticipatory Risk Premium

The crop forecast was included in the model as a proxy to measure the anticipatory risk premium effect. It measures the tendency for the basis to be bid up due to uncertainties associated with the total anticipated crop for the season and future inventory levels. When the anticipated crop is large the basis will tend to be larger, reflecting the possibility that this anticipation might not be realized influencing future prices and stock levels. It is labeled anticipatory to distinguish it from the more traditional risk premium concept which is a function of current stocks. The crop forecast used reflects the forthcoming season's crop in October.

The estimated coefficient (FP(t)) is larger for the nearer to maturity models. This difference in impact most probably reflects how the variable was defined. As the time from maturity increases, the percentage of observations that the forecast and maturation date were not for the same season increases. For the two months from maturity model the futures price addressed and the crop forecast were for the same season for all observations. For the six month model the futures price and the crop forecast were not for the same season one-third of the time. When the forecast is for one season and the futures price for the following season the nature of the anticipatory risk premium was more complex. Given these circumstances, the current crop forecast is important but so is the anticipated crop for the

next season. Crop from both seasons influence future stock levels and prices. Ideally, the next season's anticipated crop should be accounted for. However, no forecast was reported and no proxy definition appears applicable.

The short run and long run effects of the forecast at its mean level for the data period (168.3 million boxes) are shown in Table 8.1. The short run effect is the effect during the current month: the estimated coefficient (Table 7.4) multiplied by the crop forecast. The long run effect equals the short run effect divided by one minus the lagged basis residual coefficient (called the adjustment coefficient). The larger lagged basis residual coefficient for more distant models results in their long run effect being proportionally greater than their short run effect (one must consider other parameters in the models to compare actual differences in basis residual values). The long run effect measures the total impact over time, including the current month and all future months. The effect of the current crop forecast is greatest in the current month and decreases over time. The long run effects for the four, three, and two month models are similar. If the definition incorporated the forecast for the following year, it would influence all but the two month model coefficients. It is possible that the total effect would decrease as maturity approaches.

Table 8.1. Short run and long run effects of the crop forecast on the basis residual

Number of Months to Maturity	Short Run Effect of Crop Forecast at Mean Level (cents)	Long Run Effect of Crop Forecast at Mean Level (cents)
Six	0.2701	1.1091
Five	0.7770	2.9655
Four	1.6227	5.5973
Three	1.9922	5.5353
Two	2.5181	5.8670

If the crop forecast were 10 percent below normal, the short run and long run effects would be 10 percent less than those in Table 8.1. The impact is linear, a forecast 10 percent above the norm would result in the impacts being 10 percent greater than those in the table.

The above interpretation is based on the estimated coefficients and does not allow for estimation error. The model estimated is not deterministic; errors in estimation are possible. Interpretation shall continue based on the estimated coefficients, though it is not implied that the model is deterministic.

Market Liquidity and Freeze Effects

The market liquidity and freeze effects are insignificant and have very little impact on the basis residual (Table 7.4). They are included only to allow for comparison with the July contract results. The freeze effect should not be confused with the freeze bias since the freeze effect measures the impact of an actual freeze on the basis residual.

The Ward-Dasse model and the July contract models estimated here indicated a significant freeze effect. The difference in results is attributable to the difference in cash prices used. Ward-Dasse interpret the freeze variable as measuring the tendency for the cash and futures prices to differ in how fast they respond to a freeze. The results indicate that the FCB bulk price and the futures price react

similarly, while the fruit cash price is slower in responding.

<u>The Basis Residual Variable</u>

Following the Ward-Dasse model the basis residual variable definition does not reflect selling costs and Florida taxes and inspection fees paid by processors. It reflects only those costs related directly to the processing of fruit into bulk concentrate.

If these costs were included in the definition, the residual will tend to be negative, implying an inverted market most of the time. Obviously, the futures market price does not cover these costs entirely. However, if these costs are excluded as they were here, then the tendency is for the resulting basis residual to appear to be a little high as became clear as the results were analyzed.

Most probably the futures market covers some but not all of these costs. For the 1967-82 data period selling costs and taxes usually ranged from about five cents to nine cents per pound solids. If an interest expense is assumed to be associated with these costs, then their effect on the basis residual would be a cent or two more.

In interpreting the results more attention should be given to the level of the basis residual given different assumptions, rather than the absolute level of the residual. For example, noting which conditions result in a larger residual and which give lower residuals will provide more

information than if the residual is positive or negative. The predicted residual will tend to be high, reflecting the omission of selling and tax expenses.

Monthly Stock Effects

In analyzing the effect of stocks on the model it is useful to divide the discussion areas in terms of monthly effects, long run effects, and seasonal effects or seasonal patterns. Monthly effects refer to the impact of stocks during a specific month. Monthly impacts of stocks vary according to the periods and length of time to contract maturity. Long run effects refer to the long run impact of monthly effects as suggested by the lagged basis residual coefficient.

Since stock levels typically remain relatively steady for months or years at a time, it is possible to discuss seasonal effects or patterns. Due to the dynamics of the model, the monthly stock effect in one month will influence the basis residual in subsequent periods. Thus, if the monthly stock effect in September tends to have a more negative impact on the basis residual than other months, then there is a tendency for the October residual to be decreased relative to the other months. If the October monthly stock effect tends to be more positive than other months it is still possible for the October basis residual to be relatively low due to the September stock effect. Seasonal patterns are the basis patterns obtained given different stock levels.

Stock Components

The intercept was included in measuring the effect of stocks. For the July model the intercept measured quality differences between marketed fruit and bulk FCCJ traded on the futures market. Since the bulk FOB price was used in defining the basis for the constant period models, quality differences should not be a factor.

Stock effects vary depending on the month considered and the number of months until contract maturity. Following equations 7.15 and 7.16, the general form of the monthly effect of stocks on the basis residual can be written as BR{t} = f(BRS{t}, BR{t-1}, ML{t}, FZ{t}) , where BRS{t} is the impact of relative stocks and can be written as

(8.1) BRS{t} = θ{0} + (θ{5} + θ{6}D12 + θ{7}D1 + θ{8}D2 + θ{9}D3 + θ{10}D4 + θ{11}D6 + θ{12}D7 + θ{13}D8 + θ{14}D9 + θ{15}D10 + θ{16}D11) (1 / S{t}).

Where BRS{t} is the impact of relative stocks on the basis residual in period t (in cents), S{t} is the relative level of stocks, D12 is the December dummy variable, D1 the January dummy variable, etc. In January D1 equals one and the other dummy variables equal zero. Thus, for example, the total January stock effect is

(8.2) January Stock Effect = θ{0} + (θ{5} + θ{7})(1/S{t});

$\theta\{0\}$ is labeled here as the constant component and does not vary across months. What is labeled here as the stock component, $\theta\{5\} + \theta\{7\}$ in the example above, does vary across months equaling $\theta\{5\}$ plus the corresponding monthly shifter coefficient. For example, in February the stock component equals $\theta\{5\} + \theta\{8\}$. In May the stock component equals $\theta\{5\}$ since May is the base month. This treatment does not account for any possible estimation error. The estimated constant and monthly stock components are reviewed in Table 8.2 using the parameter estimates from Table 7.4.

The monthly stock effect reflects three separate theoretical components that cannot be separated because they are each a function of stocks--the convenience yield, the risk premium, and the freeze bias.

<u>Freeze Bias Dominance</u>

Increased stock levels have a positive impact on the basis residual for all months and models except December in the four, three, and two month models. For these models in December, increased stocks will decrease the basis though the effect is minimal. That is

$$(8.3) \quad \partial(BRS\{t\}) / \partial(S\{t\}) = \partial(BR\{t\}) / \partial(S\{t\}) = -(\text{stock component})(1 / S\{t\}^2).$$

where

$\partial(BR\{t\}) / \partial(S\{t\}) < 0$ in December for the 4, 3, and 2 month models

$\partial(BR\{t\}) / \partial(S\{t\}) > 0$ for all other months.

Table 8.2. Estimated constant and monthly stock components for different periods from maturity

	Number of Months from Maturity				
Month	Six	Five	Four	Three	Two
Constant	5.7800	4.7064	3.3691	3.1689	2.3842
December	-0.5282	-0.1191	0.2391	0.0431	0.1991
January	-3.5020	-2.7945	-2.0120	-1.6901	-1.3198
February	-4.4750	-3.4456	-2.5475	-2.1096	-1.5837
March	-5.0423	-4.4483	-3.6313	-3.2121	-1.9817
April	-5.2205	-3.7312	-2.8426	-2.4685	-1.8701
May	-4.8484	-3.9531	-2.7296	-2.4359	-1.7883
June	-7.1160	-5.1521	-4.1939	-2.9851	-2.2296
July	-7.3318	-6.6278	-4.3045	-3.6891	-1.9631
August	-7.3500	-7.4211	-6.0861	-4.5305	-3.1398
September	-7.0353	-6.3737	-6.8064	-6.3934	-4.1810
October	-3.4089	-3.0458	-2.5411	-3.6204	-3.3543
November	-3.2881	-2.8042	-2.2995	-2.4925	-2.9851

Changes in the level of stocks will impact the basis residual more at lower levels of stocks since the stock function was estimated in reciprocal form and, hence has asymptotic properties as stocks increase.

The unique stock effect in December for models closer to maturity is due to the freeze bias effect dominating the convenience yield and risk premium effects. During the freeze bias months, running approximately from October to February, the stock component will tend to be less negative or even positive due to the market reflecting potential impact of freezes. The difference in the impact of stocks during freeze bias months relative to other months is more pronounced when stocks are low. If a freeze should occur when stocks are relatively low, processors will have less flexibility in substituting inventories for the lost crop. They will be forced to raise prices more than if they had ample reserves to offset the crop loss. During December for the four, three, and two month from maturity models, the freeze bias effect dominates, out weighing the convenience yield and risk premium effects. While the impact of stocks is shown to be positive, the effect is actually insignificant.

Figure 8.1 shows a hypothetical case of the freeze bias dominating the convenience yield and risk premium effect where the convenience yield and risk premium are aggregated in this example. Included in the graph are the freeze bias

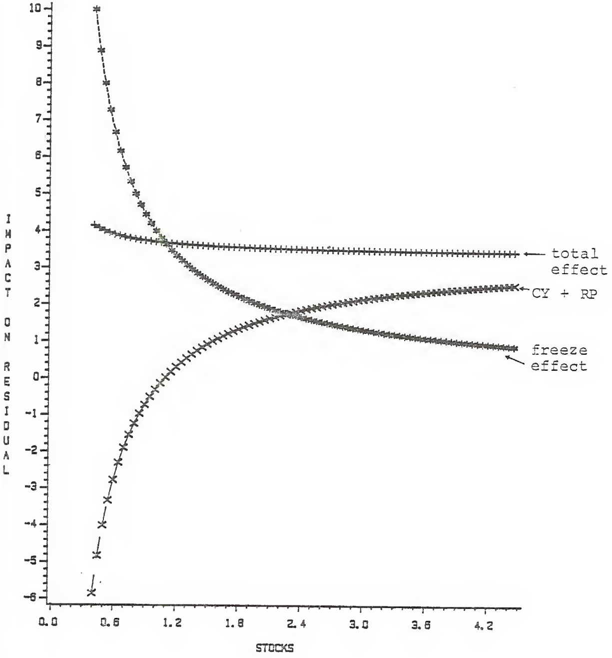

Figure 8.1. An example of freeze bias dominance

effect, the total risk premium and convenience yield effect, and the total stock effect which is the sum of the other two curves. The freeze bias effect, which decreases when stocks increase, outweighs the convenience yield and freeze bias effects which increase as stocks increase. The result being that the total impact of stocks decreases as stocks increase. A minimum value of S{t} of 0.4 is used and it is unlikely that the observed S{t} value will ever fall below this level. Actually, the total stock effect cannot be broken down into its components, as done for illustrative purposes in Figure 8.1, with the currently estimated model. The general shape of the components is known and can be represented as

(8.4) Freeze bias effect = $\phi\{a\}(1/S\{t\})$, $\phi\{a\} > 0$

convenience yield + risk premium effect = $\theta\{0\} + \phi\{b\}(1/S\{t\})$, $\theta\{0\}>0$, $\phi\{b\}<0$

total stock effect = $\theta\{0\} + (\phi\{a\} + \phi\{b\})(1/S\{t\})$.

Figure 8.1 assumes $\phi\{a\} > |\phi\{b\}|$. At extremely high inventory levels the freeze bias effect approaches zero and the total effect approaches $\theta\{0\}$ (the constant component), reflecting the risk premium. However, such inventory levels are well beyond the range encountered in the data period. The maximum value of S{t} for the data period was 1.55. Even at very high inventory levels, such as those considered in Figure 8.1 the total effect will be above $\theta\{0\}$. As reviewed in the previous chapter, the constant component measures the

maximum risk premium payable. No convenience yield exists at such high inventory levels. It was argued in the previous chapter that pressure to increase the risk premium to a higher level than $\theta\{0\}$ will result in new enterprises undertaking a storage function which will prevent the risk premium from increasing. If $\phi\{a\} < \phi\{b\}$, then the total stock effect would increase as stocks increase, approaching $\theta\{0\}$ at extremely high inventory levels. In reality the effect will be below $\theta\{0\}$ even at extremely high stock levels since levels of stocks that result in the total effect approaching $\theta\{0\}$ are well beyond those encountered in the data period.

The actual total December stock effect for different months to maturity is shown in Figure 8.2. It is not necessary for the December freeze bias effect for the six and five month models to be less than the effect for the other models as one might guess by reviewing the estimated coefficients. A more plausible explanation is that the freeze bias effect is similar for the six, five, four, and three month models in December and that differences in $\phi\{b\}$ account for the different total stock effect during these months. In December for these models, the relevant futures price is for a date after the freeze period. The potential impact of freezes should be similar and thus one would expect the extent of the freeze bias to be similar. The freeze bias may be less for the two month model in December

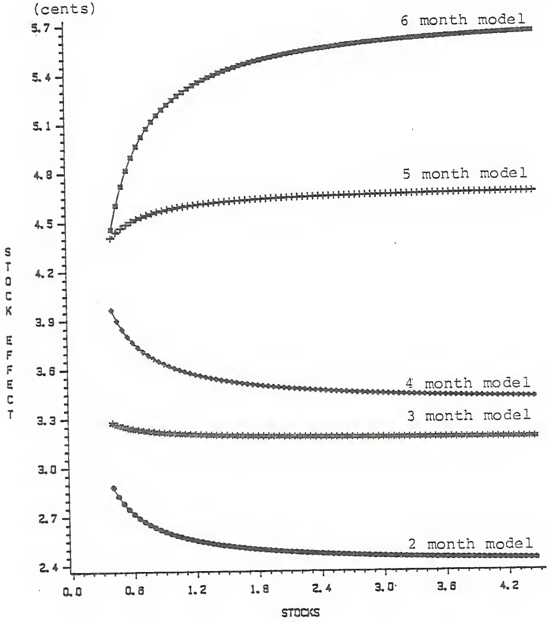

Figure 8.2. December stock effects for different periods from maturity

since futures prices for dates falling within the freeze period are used in defining its basis residual and thus the possibility of a freeze occurring before contract termination is less.

Stock Effects Within Months

For non-bias months $\Phi\{b\}$ is the stock component. For the same months, the stock component is generally more negative for the more distant model.

The total May stock effect for different months to maturity is shown in Figure 8.3. For May the constant component is positive (i.e., $\partial BBS\{t\}/S\{t\} > 0$) and greater the further the time from maturity (as it is for all months). The stock component is more negative the further the time from maturity. Given these conditions the total stock effect for two different months from maturity will cross. The further from maturity effect being greater at high stock levels and less at low stock levels. The absolute value of the stock effect is larger for the further from maturity contract at high and low stock levels. In other words, for the longer period from maturity model, the stock effect is more negative at low stock levels and increases at a faster rate as stock levels increase yielding larger values at the high stock levels. This is the type of pattern one would expect if the impact of stocks tended to diminish as maturity approached. This phenomenon was the rationale for using a time component in the constant contract model.

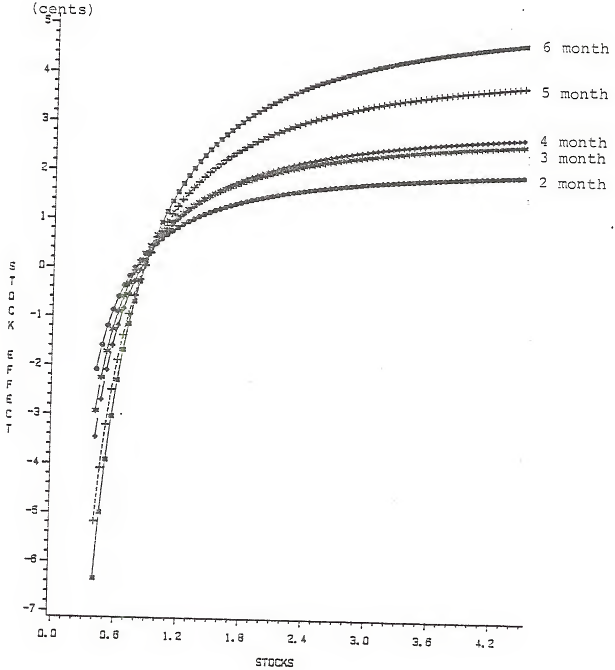

Figure 8.3. Impact of stocks for different months to maturity during May

Relative stock effects for other months tend to follow this crossing pattern. The pattern suggests that at high stock levels the basis residual will tend to narrow as maturity approaches. The implication being that at high stock levels the risk premium effect is stronger for the more distant contract, increasing its basis residual relative to contacts closer to termination. At low stock levels the convenience yield effect will be stronger for the more distant contract, thus its residual will tend to be lower. At low stock levels the residual will tend to widen as maturity approaches. Information on whether the basis residual will tend to widen or narrow is important to hedgers. The direction of basis movements determines the effectiveness of a hedge.

Instances when the crossing pattern is not followed are attributable to the freeze bias and/or the end of season certainty effect. Both are dependent on the month and termination date and thus effect the stock components for like months differently. The months of January through July exhibit this crossing pattern for comparisons between all models. Exceptions exist for the other months. In August the five month effect is always less than the six month effect for relevant values of S(t). In September the four month effect is consistently lower than the five month effect which is lower than the six month effect. In October and November none of the effects cross; the closer maturity,

then the lower the total stock effect. How seasonal factors impact the monthly stock components across models shall be clear once the discussion of seasonal factors has been completed. The December case has already been addressed.

Stock Effects Over the Year

The five month from maturity model was used in comparing differences in stock effects across the season. The stock effect for various months based on the five month from maturity model is shown in Figure 8.4 to depict how the impact of stocks varies across the year. Not all months are graphed. In August stocks have their greatest impact, while in December the impact of stocks is at its minimum. The impact for other months fall between these two extremes.

When stocks have a negative impact on the basis residual, the convenience yield effect is dominating the risk premium and freeze bias effects. Also, the freeze bias would not be expected to exist for some months. Those levels of stocks that have a positive impact on the basis residual are referred to as risk premium - freeze bias dominant. In the non-freeze bias months it is actually only the positive effect of stocks associated with the risk premium that dominates the potentially negative convenience yield effect.

For the five month model, August is the month that the impact of stocks on the basis residual switches from negative to positive at the largest stock level. This

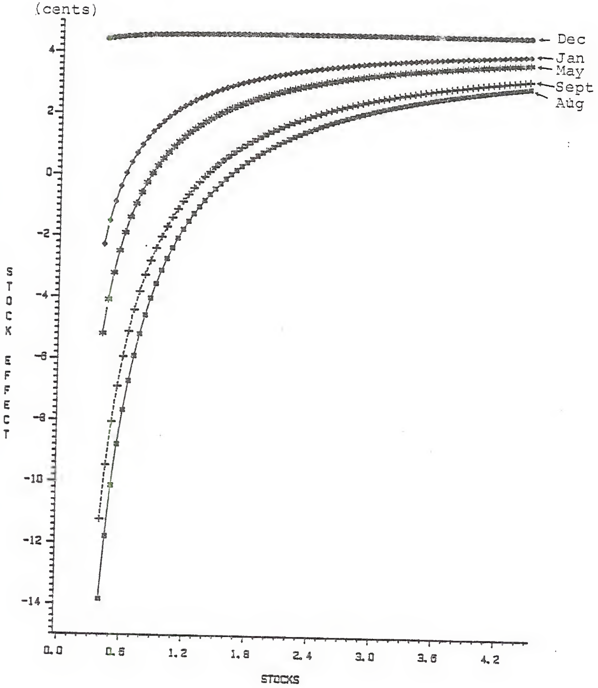

Figure 8.4. Monthly stock effect for the five month from maturity model

period shows more of a convenience yield effect and/or less of a risk premium effect compared to the other months. It is convenient to label months that display a convenience yield effect at normal stock levels (S{t} = 1.0) as convenience yield dominant months and other months as risk premium - freeze bias or risk premium dominant months. For risk premium and risk premium - freeze bias dominant months, normal stock levels have a positive impact on the basis. June, July, August, and September are the convenience yield dominant months for the five month model.

The summer months are more apt to display a convenience yield effect for the five month model. These summer months are reflecting the end of the season certainty effect when the crop is virtually harvested and season ending inventory levels are relatively easy to predict. As reviewed in the previous chapter, less uncertainty implies that the risk premium is less than other times of the year. Thus, the negative impact of the convenience yield is extended over a wider range of stocks. Additional factors that may account for the more negative impact of stocks from approximately June through September are cited when seasonal factors are discussed later in this chapter.

This end of the season effect is not reflected in October and November stock components for the five month model. It is reasonable to suspect that the positive impact of the freeze bias cancels out the end of the season effect

during these months. Actually, it appears that the freeze bias period begins before October. The stock coefficient becomes more negative throughout the summer, except in September when it increases. During September, futures prices will be maturing towards the end of winter. Thus, it is reasonable to expect a freeze bias to exist, partially cancelling out the end of the season effect. Prior to September it is possible to suspect a small freeze bias effect for contracts maturing during the freeze period. Such a possibility is not detectable by comparing the estimated stock components which decrease from month to month in the summer.

Dominance

As an aid in discussing differences in the monthly impact of stocks, it is useful to label the months for the other models as convenience yield dominant, risk premium dominant, risk premium - freeze bias dominant, or freeze bias dominant as illustrated in Table 8.3. As noted earlier, a month with a positive stock component is labeled freeze bias dominant. The impact of normal stock levels and the time of the year are the criteria used in catergorizing other months. The level of relative stocks that results in no stock effect, where the convenience yield effect cancels out the risk premium and freeze bias effects, can be found by solving the following equation which follows from equation 8.2:

(8.5) $e\{0\}$ + (stock component) (1 / $S\{t\}$) = 0.

Table 8.3. Categorizing months as risk premium, convenience yield, freeze bias, or risk premium - freeze bias dominant

Month	Categorization				
	6 Month Model	5 Month Model	4 Month Model	3 Month Model	2 Month Model
December	RF	RF	F	F	F
January	RF	RF	RF	RF	RF
February	RF	RF	RF	RF	RF
March	RF	RF	C	C	RF
April	R	R	R	R	R
May	R	R	R	R	R
June	C	C	C	R	R
July	C	C	C	C	R
August	C*[1]	C*	C	C	C
September	C	C	C*	C*	C*
October	RF	RF	RF	C	C
November	RF	RF	RF	RF	C

C denotes convenience yield dominance.
R denotes risk premium dominance.
RF denotes risk premium - freeze bias dominance.
F denotes freeze bias dominance.

[1] * Starred months are those that display the strongest convenience yield effect for each model.

If $\partial BR\{t\}/\partial S\{t\} > 0$, then the solution and criteria used are

(8.6) $S^*\{t\} = -(\text{ stock component }) / (\theta\{0\})$

where

$S^*\{t\} > 1$ then convenience yield dominant month

$0 < S^*\{t\} < 1$ then risk premium - freeze bias dominant month or risk premium dominant month in months that it is not reasonable to suspect a freeze bias.

If $\partial BR\{t\}/\partial S\{t\} < 0$, then freeze bias dominant month.

Months with a value of $S^*\{t\}$ greater than 1.0 are labeled convenience yield dominant since for these months normal stock levels will have a negative impact on the basis residual for the given value of $\theta\{0\}$. The month for each model that displays the strongest convenience yield effect, or equivalently has the most negative stock component, is starred in Table 8.3. Months with a value of $S^*\{t\}$ less than 1.0 are labeled risk premium dominant or risk premium - freeze bias dominant. For these months normal levels of stocks have a positive contribution to the basis.

When comparing a risk premium or risk premium - freeze bias dominant month to a convenience yield dominant, the impact of a particular level of stocks on the basis residual will be more negative for the convenience yield dominant month. Which effect dominates plays an important role in influencing basis residual movements over the season and thus alternative trading plans.

The months of April and May should not reflect any freeze bias or end of season effect. Comparing the March stock component to nearby months, suggests that if any freeze bias exists in March, it is only minimal. During March S*(t) values are close to one for the two through five month models. Nothing significant appears to be implied by some models being labeled convenience yield dominant and others risk premium - freeze bias dominant during this month since S*(t) is close to 1.0 for each model. From March through May the estimated stock effects do not differ much across models.

In June the six, five, and four month models are convenience yield dominant. The stock component for these models are much more negative in June than in May. In each case May is a risk premium dominant month and June a convenience yield dominant month. Thus, the end of the season decrease in the basis begins in June for the six, five, and four month models. For the two and three month models the June stock component is similar to those in March through May. In July the three month model becomes convenience yield dominant where the stock component becomes much more negative. The end of season effect is not apparent until August for the two month model when there is a switch from risk premium dominance to convenience yield dominance.

Understanding Differences In Monthly Stock Effects

Two conditions are satisfied by each model when the end of the season effect begins (1) The crop for the season has been mostly harvested - it is June or later. (2) The futures price is for the next season or close to it--the futures price is for September or beyond. The end of season effect begins when little crop remains to be harvested and the futures price is in contracts for September or beyond.

September is a key contract month because its the nearest period to the time when the October crop forecast is released. Compared to previous months, the September-October periods reflect considerable uncertainty, primarily about the new crop size. It is the period when price changes associated with the coming season are beginning to be noticeably reflected in futures prices. September prices are much more influenced by the next season's crop than are July prices are. Recall that the futures prices are for every other month and there is no October or August contract. If the end of the season effect was due primarily to cash price changes, then its onset would occur for the same month in each model since the same cash price is used in each model.

After the onset of the end of the season effect in each model, the stock effects become more negative each month until offset by the year ending freeze bias adjustments. For the three through six month models, the month of the

increase has a corresponding futures price for contracts maturing in mid to late winter (January or March). One would expect the freeze bias effect to be greater when the futures contract is for the late winter (March) since the contract extends over the entire period when freezes are likely to occur. Once the stock component increases it continues to increase until December. The two month model's stock component increases when the futures price is for early winter.

In October the six, five and four month models become risk premium - freeze bias dominant probably due to the freeze bias effect. In November the freeze bias effect is increased. The three month model does not turn risk premium - freeze bias dominant until November, when the corresponding futures price is for contracts maturing in mid to late winter. The two month model remains convenience yield dominant in November, its corresponding futures contracts are for earlier winter months. A major freeze bias effect exists for all models in December.

Figure 8.5 shows the relative stock effects across the year for the six, four, and two month models, assuming S(t) equals 1.0. The base period is May for the two month model. That is the stock effects for the other models and months are divided by the stock effect during May for the two month model so that all stock effects are relative to May of the two month model. Generally, the further from maturity, the

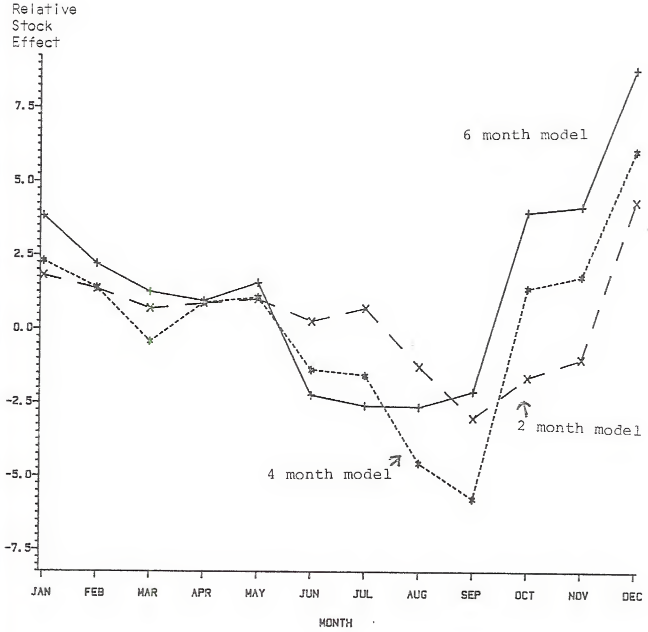

Figure 8.5. Stock effects relative to the May, two month effect

greater the stock effect due to the increased risk premium. The major exceptions to this rule are reflections of the end of the season effect. In June the end of the season effect begins for the six and four month models, being more pronounced for the six month model. At this time the six month model's stock effect switches from highest to lowest. In August, the stock effect on the basis residual is less for the four month model than the six month model since the six month model will reflect a stronger freeze bias. The end of season effect does not begin until August for the two month model. The stock effect for the two month model is much lower in October and November because the freeze bias is less than for the other models. The higher stock effect for the six month model from October through the winter months is due to both a greater risk premium associated with the longer length of time to contract maturity and to a larger freeze bias in pre- and early winter months.

Generally, greater stock levels will tend to result in less pronounced basis fluctuations across the year. Monthly stock effects for the five month contract period model are shown in Figure 8.6 letting S{t} equal 0.8, 1.0, and 1.2. The summer dip in the basis is more pronounced for lower stock levels due to a stronger convenience yield and less of a risk premium effect. In December basis residual responses are similar across the different stock levels; the stronger freeze bias effect at lower stock levels offsets the larger

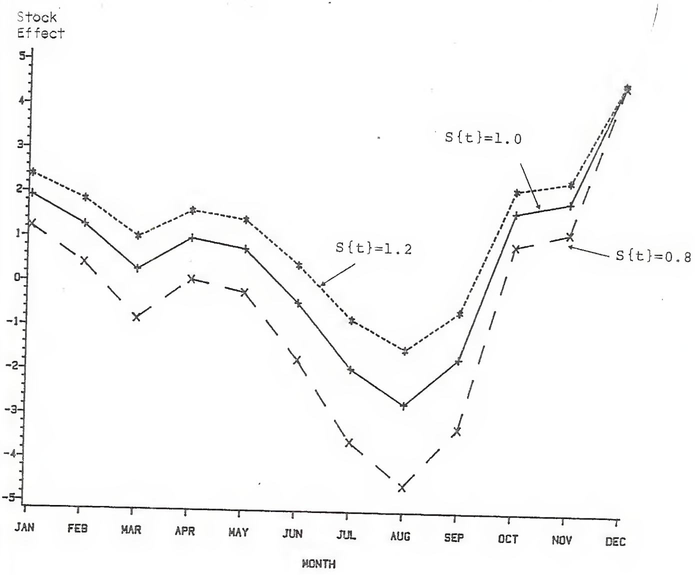

Figure 8.6. Five month stock effect across the year given different S{t} values

risk premium at higher stock levels. In other freeze bias months the larger risk premiums result in the higher stock levels having a greater impact on the basis. Differences in the stock effect across the year are more pronounced at low stock levels, as can be seen in Figure 8.6 with the greatest differences occuring in the lower curve where S(t) = 0.8.

In reviewing monthly stock effects across the year it is important to note that the lagged basis residual's impact is not accounted for. Patterns will be somewhat different when lagged effects are accounted for. These adjustments are considered after long run effects are reviewed.

Long Run Stock Effects

The long run stock components, presented in Table 8.4, are obtained by dividing the monthly components, Table 8.2, by the corresponding adjustment coefficient (as explained in Chapter VII, the adjustment coefficient equals one minus the lagged basis residual coefficient). The long run effect measures the impact of stocks on the basis residual during the current and all future periods.

Most of the adjustments and seasonal basis residual patterns noted for the current or immediate effects also apply to the long run analysis. Since the adjustment coefficient is smaller for contracts further from maturity, the tendency is for of the long run stock effects to be relatively stronger in the contracts with extended maturity periods when compared to the corresponding monthly effect.

Table 8.4. The constant and monthly long run stock components for different periods from maturity

Month	6 Months from Maturity	5 Months from Maturity	4 Months from Maturity	3 Months from Maturity	2 Months from Maturity
Constant	23.737	17.963	11.622	8.805	5.555
December	- 2.169	- 0.455	0.825	0.120	0.475
January	-14.382	-10.666	- 6.940	- 4.696	- 3.308
February	-18.878	-13.151	- 8.788	- 5.862	- 3.690
March	-20.708	-16.978	-12.526	- 8.925	- 4.617
April	-21.439	-14.241	- 9.806	- 6.859	- 4.357
May	-19.911	-15.088	- 9.416	- 6.768	- 4.167
June	-29.224	-19.665	-14.467	- 8.294	- 5.195
July	-30.110	-25.297	-14.848	-10.250	- 4.574
August	-30.185	-28.325	-20.994	-12.588	- 7.316
September	-28.892	-24.327	-23.478	-17.764	- 9.741
October	-13.000	-11.625	- 8.765	-10.059	- 7.815
November	-13.503	-10.703	- 7.932	- 6.925	- 6.955

The influence of current stocks on future months decreases over time.

Seasonal Patterns

When comparing differences in monthly stock effects across the year, the greatest variability in the stock effect is between June and December. The monthly stock effect is relatively stable for the first half of the year.

By the end of June the crop is nearly harvested, while in December the early crop for the new season is just beginning to be harvested. Changes in the stock levels in the latter half of the year result primarily from changes in demand and imports. According to the estimated models, basis residual movements, which are basically a function of S{t} and the lagged dependent variable, will tend to follow a relatively easily predicted course from June to December. Given a fixed value for S{t} and a starting basis residual value, a good representation of the implied changes in the basis residual can be obtained by setting all other explanatory variables to constant values and using the lagged predicted residual in the current period's projection. Changes in the basis residual from one month to the next would be due to the differences in the monthly stocks and lagged basis residual values. Changes in the predicted basis residual would reflect current and all previous stocks, thus giving the long run impact for each period.

In other words, to consider the effect of stocks across the entire year, fix a level of S{t} and other explanatory variables and let only the lagged dependent variables change. In this way it is possible to view basis residual movements across the year given different stock level assumptions. Such information is important to hedgers who wish to know when to expect a narrowing or widening of the basis.

The predicted monthly values for each model were obtained using the above approach. All explanatory variables were set at their mean value of the data period except the freeze variable which was set to zero. Different values of S{t} were considered. The results of this exercise are based on the predicted basis residual values extending the analysis over six years. After six years it is possible to isolate the total impact of S{t} and lagged influences of S{t} on the model. The predicted values for the sixth year and beyond are equal for like months (for the same period from maturity model). The predicted values for corresponding months will change slightly up to the sixth year. Stabilization of predicted values from year to year occurs once the initial assumption as to the value of the lagged dependent variable for the first period of the simulation has no impact. Regardless of the initial value of the lagged dependent variable used, the resulting predicted values after the fifth year are the same when

initial values falling within the range of the data are considered. Thus, after five years the current and lagged influences of stocks can be isolated from the initial lagged basis residual assumption. Changes in the basis residual from month to month are entirely due to current and lagged influence of stocks.

Basis Patterns at Different Stock Levels

The resulting basis residual values across the year for each model are presented in Figure 8.7 through Figure 8.11 for S{t} values of 0.8, 1.0, and 1.2. When the constant period models are compared for the same month, a larger S{t} value results in a higher basis residual, reflecting more of a risk premium effect at higher stock levels and a stronger convenience yield effect at lower stock levels.

In interpreting the results of this exercise it is important to remember that selling costs and a grower fruit tax are not included in calculating the basis residual as explained earlier. These costs average about seven cents and would decrease the basis residual a like amount if included. Interest expense on these costs if included would lower the residual another fraction of a cent. It is unlikely that these costs are fully reflected in the futures price. Due to the omission of these costs it can be misleading to consider the value of the basis residual as shown in these figures. For example, a residual value close to zero, like 2.0 or 3.0, may imply a convenience yield

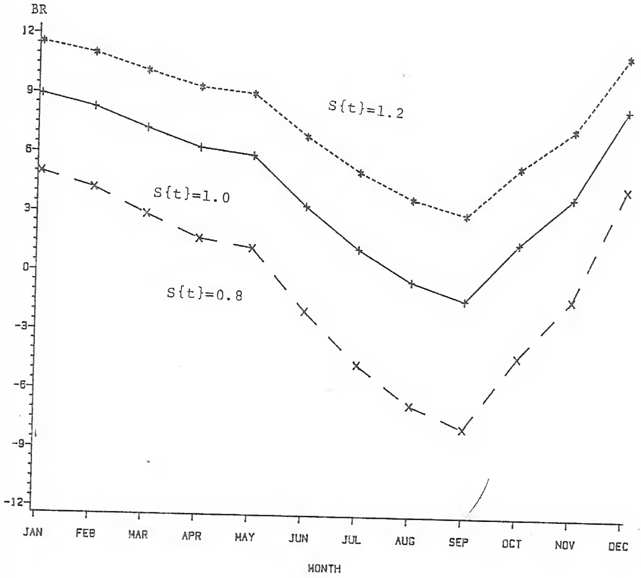

Figure 8.7. The effect of stocks on seasonal basis patterns for the six month model

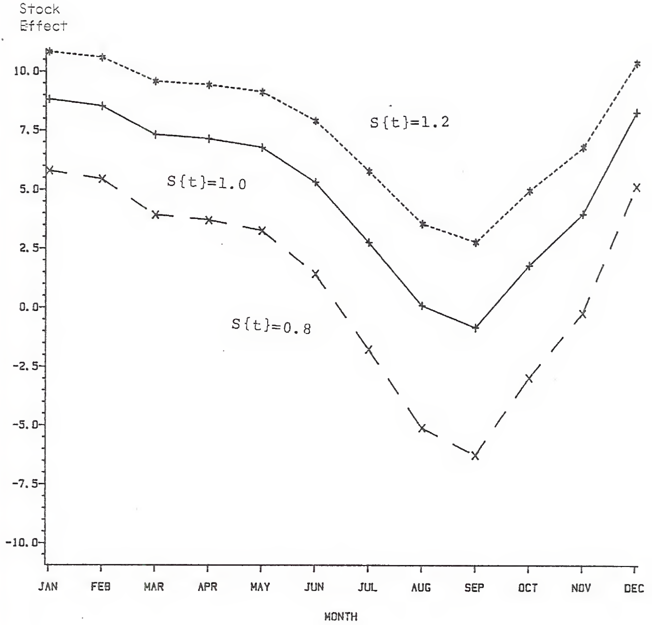

Figure 8.8. The effect of stocks on seasonal basis patterns for the five month model

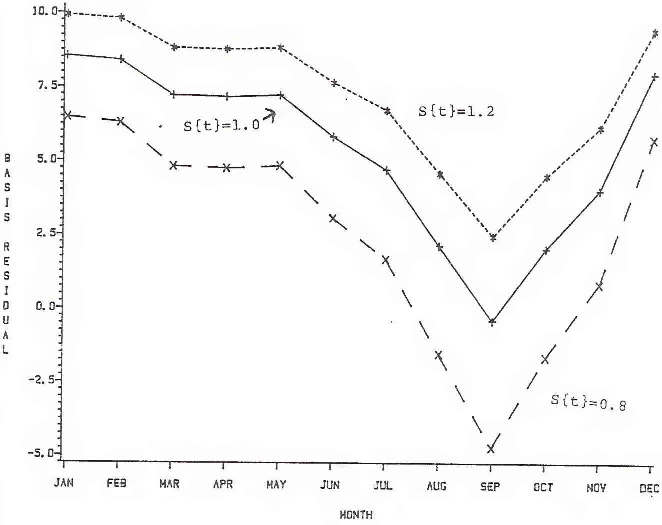

Figure 8.9. The effect of stocks on seasonal basis patterns for the four month model

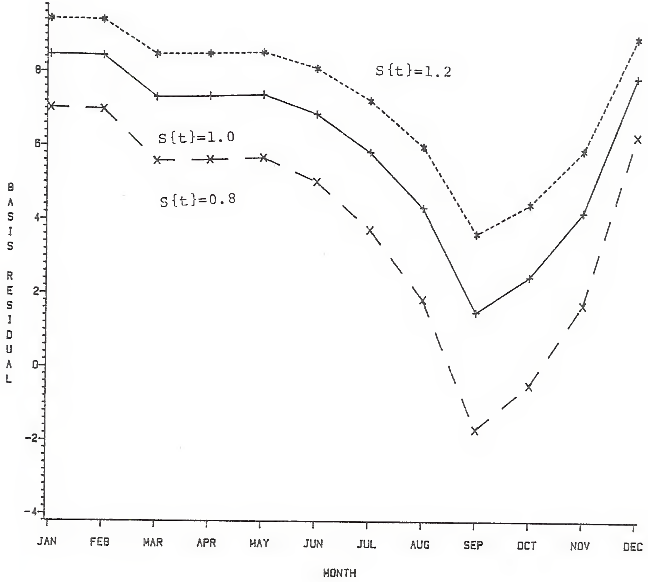

Figure 8.10. The effect of stocks on seasonal basis patterns for the three month model

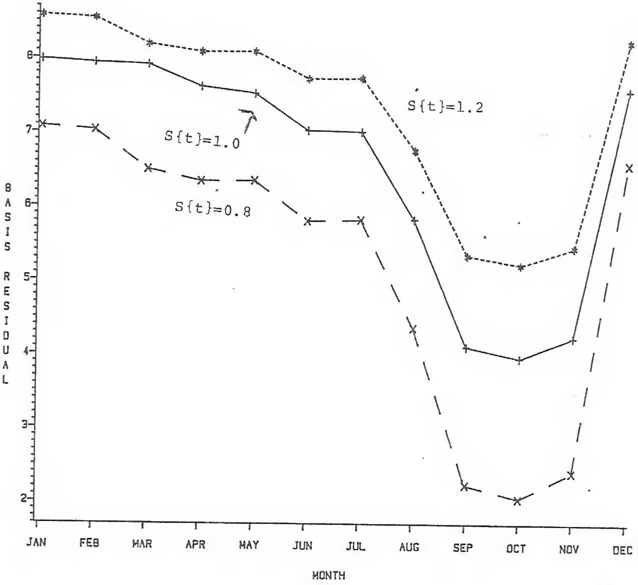

Figure 8.11. The effect of stocks on seasonal basis patterns for the two month model

effect. Typically a convenience yield effect is associated with a negative basis residual. Comparing basis residual values over time, across different models, and for different levels of S{t} should not be misleading, however.

Generally, the longer from maturity, the greater the difference in the basis residual when comparing high and low stock levels for the same month. Exceptions are due to differences in seasonal variations. This pattern reflects the tendency for stocks to have less of an impact as the termination date approaches. The convenience yield and risk premium effects tend to have more of an impact on those contracts further from maturity. The result is a relatively small residual at low stock levels and a large residual at high stock levels in the more distant contracts.

Though theoretically the freeze bias effect is greater at low stocks, when comparing like months for the same period to maturity, the residual is larger given high stocks. This increase in the residual at higher stock levels during freeze bias months is attributable to a stronger risk premium effect at high stock levels and a stronger convenience yield effect at low stock levels.

The level of stocks has more of an impact in determining the degree of the summer dip in the basis than it does in determining the extent of the freeze bias. For each model the difference in the basis residual when comparing high and low stock levels is greater towards the end of the season

than during winter freeze bias months. The basis residual is flatter across the year at high stock levels. Again this is fully consistent with earlier results. A larger difference exists between the peak and low basis residual values during the year at lower stock levels.

The basis residual peaks in January for each model and S{t} value. September is the month of the lowest basis residual value except for the two month model which reaches its low in October.

Additional insight can be gained by comparing basis residual for different periods from maturity given a constant level of stocks. The predicted basis residual for each period from maturity holding relative stocks at 0.8 are reviewed in Figure 8.12. The residuals plotted in Figure 8.12 are the same points plotted in Figures 8.7 through 8.11 presented to allow for easier comparisons between models.

At low stock levels during the same months the basis residual is lower the further from maturity due to a stronger convenience yield effect at these low stock levels. The differences between models are less pronounced during summer months. If one makes some allowance for selling costs and taxes the residuals would be lower implying an inverted market in many instances.

Taking a Constant Contract Perspective

By considering the predicted basis residual one month and the predicted value the next month for the model that is

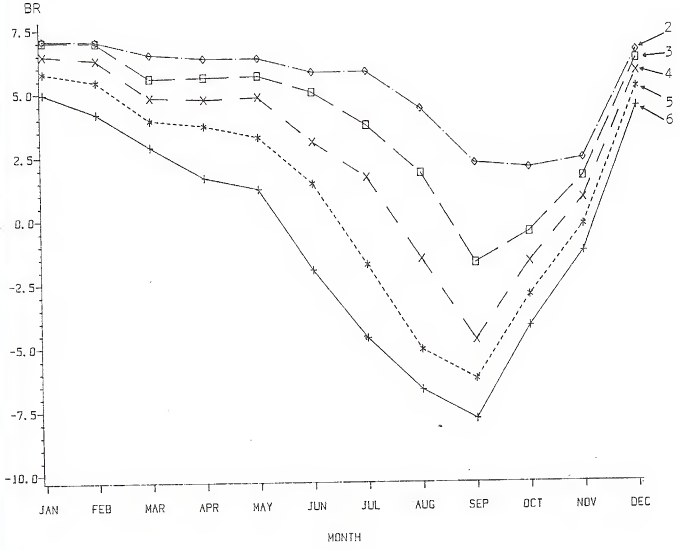

Figure 8.12. Comparison of seasonal effects across models given S{t} equals 0.8

one month closer to maturity one can get an idea as to how the basis residual adjusts for the same contract as it matures.

Low stock effect. A comparison of this type is shown in Figure 8.13, which is constructed by connecting the predicted basis residual values of Figure 8.12 to form a line to represent basis residual values for the same contract over time given stock levels of 0.8. The January, March, May, July, September and November contracts are portrayed. The July contract representation, for example, uses the five month from maturity predicted basis residual in January, the four month in February, the three month in March, and the two month in May. The other contracts' series are constructed similarly. To allow for continuous treatment of the March and May contracts the months of January, February, and March are considered twice in Figure 8.13 rather than having a discontinuity in these curves. As noted previously, the results of this exercise will continue to be repeated if residuals beyond the sixth year are considered. Thus, the March and May curves could also be considered for periods prior to the July curve.

Figure 8.13 implies that the basis residual tends to increase as maturity approaches at low stock levels. The July and May contracts' residuals decrease from February to March as the freeze bias effect decreases.

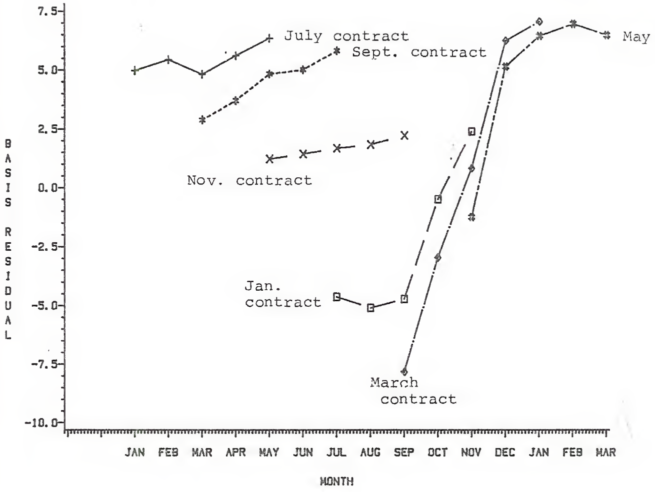

Figure 8.13. Implied seasonal contract movements when S{t} equals 0.8

If selling costs and taxes are included, the market will often to be inverted with the residual being negative. Actually, the results imply that futures prices are decreasing over time. When adjacent contracts are compared, for example the July and September contract, the basis residual is lower for the contract further from maturity. Since the cash price for the two basis residuals are the same, the implication is that the futures price of the more distant contract is probably lower.

This convenience yield effect is least pronounced between the March and May contracts and increases after these months are considered. Comparing the May contract to the July contract the convenience yield effect is greater than for the March-May comparison. Comparing July to September, September to November, and November to January the convenience yield effect grows with each comparison, reflecting a lower futures price over time. A decrease in the risk premium as the season progresses and certainty increases, as cited in the previous chapter, would help explain this strong convenience yield effect.

The model also implies a strong convenience yield effect towards the end of the season, reflecting anticipated price decreases associated with the new crop. The futures price decrease for the November contract relative to the September contract and for the December contract relative to the November contract includes an anticipated price decrease

associated with the new season. These anticipated price decreases are apparently due more to the cross seasonal effect of the new crop than convenience yield considerations within the season. This cross seasonal convenience yield effect is difficult to isolate when stocks are low and is more easily seen at higher stock levels as will be obvious when the results for high stocks are reviewed. The cross seasonal effect explains why the November and January futures prices, Figure 8.13, are much lower than the September futures price. The effect measured by the model is an average interseaonal price change that is influenced by stocks. The interseasonal convenience yield effect is analyzed after the basis residual patterns at high and average stock levels have been presented.

High stock effect. Curves corresponding to those in Figure 8.13 for an S{t} value of 1.2 are contained in Figure 8.14. The implied movements in the basis residual over time, Figure 8.14, shows a risk premium effect, the residual tends to increase over time though there is a convenience yield effect associated with price decreases across seasons. The basis residuals are consistently higher when comparing the March, May, July, and September contracts during the same time periods. These relationships reflect the tendency for the futures price to be greater later in the season. The November residual is lower than the September residual for months closer to maturity, implying a slight decrease in

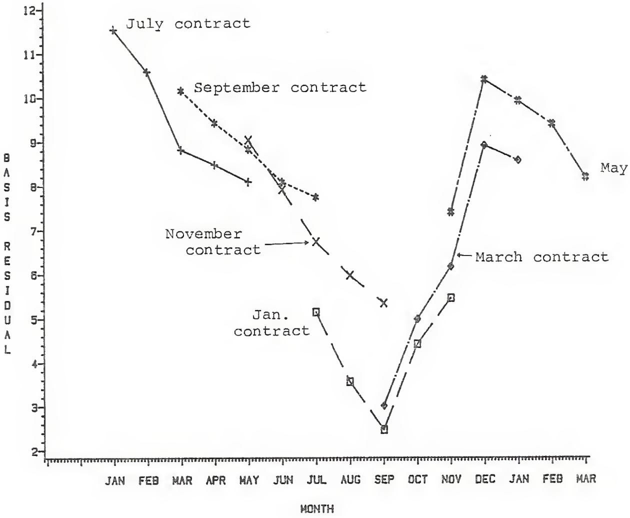

Figure 8.14. Implied seasonal contract movements when S{t} equals 1.2

the expected price between September and November. The November basis residual recorded in May can be attributed to a stronger risk premium effect at this time reflecting its being further from termination. The November residual decreases throughout the period considered probably due to a decreased risk premium as maturity approaches. Similarly, the January and March residuals decrease until a low is reached in September as would be expected by the proposed end of season certainty effect.

Figure 8.14 shows the March contract residual being lower than the January contract residual, which is lower than the November contract residual. The November contract residual is lower than the September residual for months closer to maturity. Comparisons for other contracts reveals that the basis residual for the more distant contract is larger as theory would explain with the risk premium concept. Thus, at high stock levels FCOJ futures prices tend to increase over time, except for contracts maturing during the interseasonal period. Futures prices imply an anticipated price decrease or a series of price decreases during the interseasonal period. The increase in the January, March, and May contract residuals during the October to December period is a reflection of price decreases associated with the new crop and a freeze bias effect.

Average stock effect. Results for the S{t} equal 1.0 condition are reviewed in Figure 8.15. The March and May residuals peak in January. A clear statement as to the dominance of the convenience yield or risk premium effect early in the season cannot be made. The July residual, for example, widens very slightly after the freeze potential passes in March. The September residual moves up and down. Evidently there is still a strong convenience yield effect at average stock levels that tends to offset the risk premium effect. Such a result, however, is of little use to the hedger, who wants to know if the residual will tend to narrow or not. A definite answer is not possible. Perhaps the best guess would be to consider the effect that current pricing is having on inventories. If pricing is resulting in increased inventories and inventory levels are close to normal, then the model implies that the July and September residuals would tend to widen after March. A narrowing would be more likely if industry pricing is depleting inventories.

All other contracts are influenced somewhat by the interseasonal price decrease. As with the results for the high and low stock conditions, it is implied by comparing the July through December contracts that there is an anticipated price decrease or several price decreases during the interseasonal period. This interseasonal effect is analyzed in the next section.

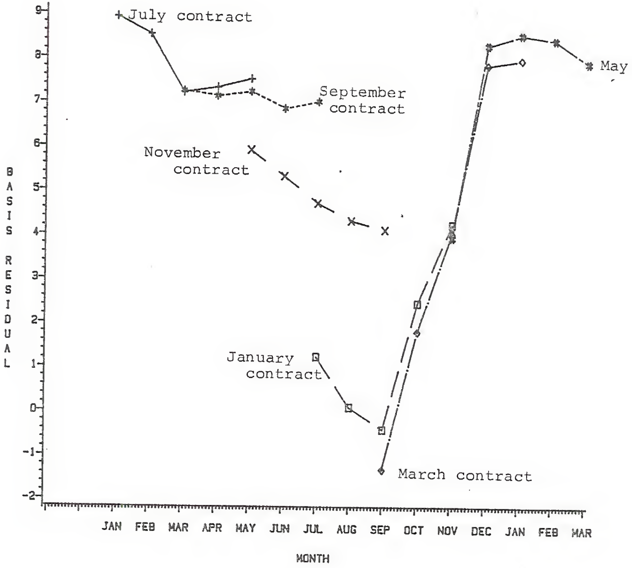

Figure 8.15. Implied seasonal contract movements when S{t} equals 1.0

The rather strong convenience yield effect at average stock levels most noticeable for the July and September contracts, suggests that average stock levels over the data period do not necessarily represent desirable stock levels. At a S{t} value of 1.05 the classical narrowing of the residual will be evident throughout the year (except in the interseasonal period). Thus, stock levels of 1.05 are probably more indicative of processor goals than levels of 1.0. Freezes played a key role in determining average relative stock levels for the data period.

Evidence of a convenience yield effect even at average stock levels and the tendency for the contracts further from maturity to be influenced more by the dip in the basis residual towards the end of the season help explain why the average basis residual values for the data period are greater the closer to maturity considered. The average residual values for the two through six month models are 6.22, 5.54, 4.85, 4.22 and 3.51 cents per pound solids, respectively. If one were to fully weight selling costs and taxes in defining the basis residual, then the resulting mean basis residuals would be negative. A review of mean basis residual values across the year for the different models is presented in Table 8.5.

<u>Interseasonal convenience yield</u>. As noted previously there is an implied interseasonal price decrease which can be detected by comparing the July, September, November, and

Table 8.5. Mean basis residual values by month for the different periods from maturity

Month	Mean Basis Residual Value				
	6 Month Model	5 Month Model	4 Month Model	3 Month Model	2 Month Model
December	7.099	7.283	7.362	7.409	7.446
January	7.386	7.533	7.722	7.749	7.608
February	7.021	7.446	7.642	7.792	7.751
March	5.928	6.188	6.423	6.612	7.172
April	4.907	5.996	6.368	6.678	7.003
May	4.704	5.805	6.558	6.798	7.014
June	2.602	4.571	5.164	6.333	6.643
July	0.884	2.433	4.194	5.538	6.756
August	-0.638	-0.028	1.865	3.994	5.492
September	-1.335	-0.727	-0.201	1.608	3.954
October	1.039	1.412	1.810	2.352	3.775
November	2.888	3.207	3.565	3.871	4.244

January contracts' basis residuals in Figures 8.13 through 8.15. Implied is a gradual price decrease that in some case may extent beyond December. The tendency for futures prices to imply anticipated price decreases from October to December is important because it along with the freeze bias explain the rapid rise in the basis residual from October to December.

The rise in the residual from October to December often reflects price changes associated with the new season. This cross seasonal effect will result whenever futures prices previous to October suggest that a price decrease is anticipated during the interseasonal period.

If the anticipated price decreases suggested by the September, November, and January futures contracts prices in the summer months are accurate, then cash prices will tend to decrease as the anticipation is realized from about October through December. Since given an accurate anticipation futures prices for the same contract will not change much from their summer levels, the basis residual will widen from October to December due to lowering cash prices and the freeze bias effect. Cash prices must decrease because it is assumed that previous futures prices prove to be accurate.

Since the crop forecast for the new season is not released until October, it is more likely that there will be a revision of expectations. If the consensus opinion is

that previous futures prices were too low, then futures prices will tend to increase. However, since cash prices will not decrease as much as they would in the perfect anticipation example above, the adjustment in the residual from October to December will be similar. If, for example, previous anticipated futures prices were five cents too low, then during the October to December period the futures price will rise five cents. Also, cash prices from October to December will be about five cents greater than for the perfect anticipation example. The five cent decrease in futures prices is cancelled out by the difference in cash prices relative to the perfect anticipation example in calculating the basis. If the previous futures prices were too high, then futures prices will decrease from their summer values and cash prices will decrease more than they would given perfect anticipation. The difference in cash and futures prices relative to the perfectly anticipated case cancel each other out in calculating the basis. Thus, similar adjustments in the basis residual would result given an anticipation of a price decrease, whether the anticipation proves accurate or not.

The effect of the crop for the coming season is not treated fully by the model. The results obtained represent some average type of interseasonal price adjustment based on stocks.

If a smaller than average interseasonal price decrease occurs at low stock levels, Figure 8.13, and is anticipated in pre-October months, then the November and January basis residual curves should be pushed up with the January curve still being the lowest and the September curve the highest. The March and May curves should be higher in the months before December. A higher than average anticipation previous to October would push these graphs down.

A steep rise in basis residuals from October to December also exists at high S{t} levels, though it is more pronounced at lower S{t} values as would be expected. At high stock levels, if there is no anticipated price decrease across seasons and this anticipation is reflected in futures prices, then most likely the November residual, Figure 8.14, would be above the September residual throughout the period considered. The January residual would probably be above the November residuals. There would probably still exist a turning up of the January and March residuals due to the freeze bias effect. Whether this increase would occur in October or later is not clear. The tendency for basis residual values to be lower towards the end of the season should still exist.

The anticipated price decrease across seasons most probably reflects the tendency for the anticipated crop to increase from one year to the next. At lower inventory levels it appears to imply a seasonal convenience yield

effect. Given low inventories processors will tend to set current prices higher so that inventories can increase to more desireable levels. When the new crop is near, it becomes possible to lower prices and still have inventories increase in the near future because of the new supplies. At low inventories the new crop anticipation will usually be larger than the last.

At high inventory levels two possibilities exist. If the market is paying processors for carrying excess inventories, then prices will tend to increase over time due to the risk premium. Most likely the new crop will tend to result in an additional accumulation of inventories, forcing a lowering of prices to remove the inventory burden. This accumulation will tend to occur even if the new crop is slightly less than the previous crop because prices will have increased since the previous crop, given that the market is paying for carrying high inventories. Less likely is the possibility that the new crop will lead to additional price increases in payment for the added risk premium associated with carrying more stocks. Historically, relatively large inventories were rarely carried for periods more than a year and when they were extremely high they usually decreased in a short period of time. Thus, there appears to be some limit on the risk premium payable. When this limit is approached and additional supplies are forthcoming, processors are forced to decrease prices. If

the market is not paying for carrying the inventories (not paying for the relatively large risk premium associated with large inventories), then inventories will tend to decrease because prices will be relatively low.

Even at high inventory levels there are convenience yield aspects to the phenomenon. A straight forward application of storage theory suggests no reason why the effect of next season's crop should have a noticeably different impact during the interseasonal period. As explained in Chapter I, prices previous to this period should be influenced also. For FCCJ there could exist a yield in waiting to lower prices or waiting to fully adjust prices and thus bring inventories in line. By waiting to adjust prices it is recognized that the anticipated crop for the next season is very uncertain until the freeze period passes. By carrying extra inventories into the freeze period, additional freeze protection is gained. Accepting this argument implies a stronger convenience towards the end of the season. The argument is applicable given high or low inventory levels.

The model treats the general case of the cross seasonal price change as a function of stocks. It is possible that there will be no interseasonal price decrease or even an increase. An actual decrease is not necessary, only an anticipation of one before October to exhibit a convenience yield effect across seasons similar to those depicted in Figures 8.13 through 8.15.

Basis Residual Changes Over Time

Various specifications were estimated using the Cooley-Prescott time varying parameter procedure as noted in the previous chapter. For each specification no change in parameters over time was found. This time varying parameter procedure is very flexible for modeling parameter adjustments. Thus, it is extremely unlikely that slightly different specifications would change this general result. The procedure is also useful for tracing unaccounted seasonal variations, suggesting major unaccounted seasonal effects and changes over time are unlikely.

The possibility of there actually being some change in parameters over the data period is still possible. The two major assumptions in the Cooley-Prescott method that can influence the results are that the exact composition of the covariance matrices is not known but must be assumed and that the permanent versus transitory adjustments in the estimates are assumed to be fixed from period to period.

A number of alternative specifications of the covariance matrix were analyzed and each result implied no parameter adjustments over time. It appears unlikely that the covariance assumption is too restrictive.

If in fact the relationship between permanent and transitory adjustments varies over time, it is unlikely that the procedure will not respond to this variation and show some degree of parameter adjustment over time. The

parameter estimates in all cases consistently pointed towards stable parameters.

Trends

Based on consideration of the final specification used in this study (Table 7.4), one might suspect that some adjustment over time or trends might be accounted for by the nature of the specification. Specifications similar to the final model in Table 7.4 but without the lagged basis residual variable show no adjustment when estimated using time varying parameters. Ordinary least squares estimates using twelfth differences result in a constant term that is virtually zero, implying that there is no tendency for the basis residual to increase or decrease over time. As explained in the previous chapter, twelfth differencing requires defining all variables in terms of their changed value relative to a year ago.

The lagged basis residual variable is measuring rigidities that are relatively short term in nature more so than some trend extending over several years. There is no obvious trend in the residuals across the data period (see Table 4.2). For the first five seasons of the data period the basis residual for the four month model varied between -17.770 (October, 1968) and 9.493 (January, 1970). For the final five seasons the low was -17.973 (September, 1978) and the high was 10.743 (December, 1979).

<u>Changes in Stocks</u>

Constant parameter values do not necessarily imply that basis patterns have not changed. Changes in the levels of explanatory variables over time, especially stocks, would imply a difference in basis levels over time. It is reasonable to suspect that imports might influence stock holdings in some way. Since imports provide an alternative to carrying stocks, there is a theoretical tendency for stock levels to decrease as the reliance on imports increases. Supplies can be imported when needed rather than stored. However, given increased imports and the increase in out of state processors, Florida processors might face greater price uncertainty. Theoretically, a greater degree of uncertainty could tend to increase stock holdings.

Data in Table 8.6 do not reveal a major stock shift in holdings. Recall that S(t) is equivalent to the number of weeks of supplies held for the month divided by the average number of weeks of supplies held for the corresponding month over the data period. The division of the data period in Table 8.6 is arbitrary though similar results are obtained for other divisions. Comparison of average stock holdings indicates that for the first seven years of the data period slightly more supplies were held on the average from July through November. From December through June slightly more supplies were held on the average for the final eight years of the data period.

Table 8.6. Monthly comparison of average number of weeks of supplies held by processors

Month	Supplies December, 1967 through November, 1974	Supplies December, 1974 through November, 1982
December	11.52	12.78
January	14.93	16.05
February	19.44	20.64
March	21.71	23.35
April	21.86	24.03
May	25.59	27.33
June	29.54	29.75
July	29.58	28.10
August	25.54	24.28
September	21.37	20.11
October	17.09	15.91
November	12.61	12.49

A major shift in inventory holdings is not evident based on this analysis. The differences noted probably reflect the tendency for imports to be greater during and near the winter months. Season ending inventory levels do not appear to have changed.

CHAPTER IX

IMPLICATIONS OF THE RESULTS

In the previous chapters the FCOJ basis was modelled for both a constant period from maturity model and a constant contract model. Empirical basis estimates show the relationships of the basis with the fundamental economic characteristics of the market and how they adjust across contacts and over time. In this chapter, these empirical models will be utilized to address a number of policy and trading issues of particular importance to the FCOJ market. Specifically, in this chapter, the theoretical and empirical results can be used to provide additional insight into the following: dynamic basis theory; market performance and price efficiency; trading stradegies; and expectations and market forecasting. In the subsequent discussions, each of these often inter-related topics will be considered as they relate to the empirical results.

Theoretical Market Performance

The FCOJ futures has now been trading in excess of 18 years and its use has fluctuated considerably across seasons. The market has existed long enough to adjust to

the normal maturing process so often associated with the initiation of a new contract. Is contract performance consistent with existing theory of storage? This theoretical question can be addressed with what has been learned from the empirical studies of both the constant period and constant contract models.

Fundamentaly the futures basis reflects the levels of existing stocks that must be carried through time and discounts or adds premiums in accordance with risk and market expectations for the future. The market should reflect the cost of storage but may not after netting out all of those conditions impacting future transactions. For example, qualities may be different, expectations for future supplies must be set, and actual storage cost may be under or over estimated. Such conditions can all be used to explain why a market may not just reflect the cost of storage. Likewise, as seen in the FCOJ market, the seasonal potential for windfall gains can lead to seasonality in the basis. Given these circumstances, what do the empirical results shows us about the theoretical consistency of this market?

Stocks

Central to storage theory are the concepts of risk premium and convenience yield both of which are traditionally viewed as functions of stocks. The risk premium is a bidding up of the basis as stocks increase in

order to compensate the holders of stocks for the risk incurred. The convenience yield is a narrowing of the basis at low stock levels and represents a return to the holders of stocks, in the form of a higher cash price, for allowing stocks to fall below desireable levels.

Since both convenience yield and risk premium are functions of stocks, no attempt was made to seperate their impact on the basis. Rather, the total impact of stocks was measured.

In both the fixed contract and fixed period models, the driving force impacting the basis was related to the level of stocks as would be theoretically expected. As stocks rise, the FCOJ basis increases, thus providing the economic incentive for storage. This result supports the categorization of the performance of the FCOJ futures market as efficient.

The impact of stocks on the basis varies from month to month. A ramification of the fluctuation in the impact of stocks is for the basis residual to move rather predictably during certain periods or seasons of the year.

Seasonal Patterns

The seasonal nature of the FCOJ basis, tending to widen or narrow during certain periods may be cited by some in questioning the performance of the FCOJ futures market. The rational behind such an argument would focus upon hedging interests. Any tendency for the basis to widen or narrow

should tend to attract hedgers, who would take positions that counteract the seasonality in the basis.

One such seasonal tendency has been referred to as the freeze bias and results in the basis tending to be larger in winter and pre-winter months. The freeze bias is a reflection of long speculative interests bidding up the futures price, hoping to profit from a freeze. Once winter passes, the basis tends to narrow. Such a predictable movement in the basis is to the advantage of short hedgers, who will usually profit from a narrowing of the basis. Why then does not the best interest of short hedgers (short hedgers are those that sell foward) result in a lowering of the futures price and the basis as they sell foward? That is, why does not the influence of hedging activity simply negate the freeze bias?

Processors are the main group of potential hedgers and they are few in number. It is possible that the uncertainties involved and rates of return for alternative investments limits their trading. Generally, to best take advantage of the freeze bias, hedgers would sell forward in early December. During this period the season's early fruit is just beginning to be harvested. To hedge short, processors would often have to hedge fruit that they have not yet procured. Such a hedge could prove quite costly if future inventories are lower than anticipated, especially if a freeze should occur. Hedging anticipated supplies that

prove not to be forthcoming results in returns being based on futures price movements and if a freeze should occur the short hedgers take substantial loses on the futures side of the hedge commitment. Hedging stocks not yet procured involves much risk, especially in the winter months. While other studies have shown that the short hedgers do trade against this freeze bias, these anticipatory inventories are crucial in setting upper limits on how much short hedging occurs.

A major contribution of this study is the identification of the tendency for the basis residual to take a relatively large dip towards the end of the season. The residual following this dip will tend to increase rapidly from October to December and can be used to the advantage of many long hedgers for short periods (long hedgers are those that buy forward). This basis widening is apt to be largest when futures prices for the next season prior to October reflect an anticipated price decrease across seasons. A widening of the basis during this period is also likely to occur due to higher futures prices associated with the freeze bias effect, which is not influenced by interseasonal price changes.

During this period inventories are decreasing and generally less hedging occurs. The limited extent of long hedging interests perhaps helps explain why this pattern persists. Also a large portion of existing inventories is

already hedged short. Most importantly, processors use of long term contracts with growers, such as participation plans or cooperatives, lessens their need to buy futures forward. Generally 70 to 80 percent of the season's crop is under some type of forward contract. Contracting provides processors assurance that supplies were forthcoming in the future. Processors often need not buy forward in order to obtain future supplies. Thus, it appears reasonable that seasonal tendencies in FCOJ basis movements continue.

More is probably involved in hedging motives than noted above. For example, often large processors are reluctant to use the market because they realize that others will react to their actions and thus potentially disrupt the market. Clearly, these tendencies can be exploited by particular hedgers according to their individual circumstances. It is possible that certain hedgers do not hedge optimally; studies such as this should aid them in devising hedging stradegies.

Related to seasonal basis patterns is the tendency, noted by Ward-Dasse (1977), for the basis to jump for a few weeks following a freeze. The Ward-Dasse model employs the fruit spot price. When the bulk cash price is used in defining the basis this tendency does not exist. The implication being that fruit prices are slower to increase due to a freeze than futures and bulk prices. This result does not point towards inefficencies in either the futures or fruit market. Rather, immediately following a freeze

there is often an abundance of damaged fruit that must be marketed, depressing fruit prices. If the fruit suffers some freeze damage there is some question about its economic value. Also, fruit spot prices are related to the wholesale price of retail sized FCOJ. Buy-in-policies insure a two or three week notice before this price can be increased.

Imports

A major concern of this study was the impact of imports on basis movements. Imports which have trended upwards in recent years will influence stock levels, the degree and type of risk faced by potential traders, and the composition of traders. Storage theory or basis theory does not treat imports directly. Thus, it was hypothesized that increased importing might lead to a change over time in the impact of the explanatory variables on the basis residual. No evidence of a change in the impact of explanatory variables was found. The impact of imports is limited to the role they play in determining the current level of inventories as reviewed later in this chapter. The stability of FCOJ basis residual determinants does not provide evidence of the performance or efficiency of the FCOJ futures market. For another commodity such a change in import availability might lead to a change in the impact of explanatory variables. One can not make a statement connecting imports, changes in structure, and performance simply because imports are not directly considered by storage theory.

Empirical Performance

Stocks are the most important determinant of the basis residual. The importance of stocks is more evident in the constant period models since for these models seasonal basis patterns are also conceptualized as a function of stocks. The stock effect for the two through six month from maturity basis models is graphed in Figure 9.1 assuming an S{t} value of 1.0 The stock effect was measured by adding the constant term to a set of monthly dummy variables which were multiplied by 1/S{t}, where S{t} is relative stocks or the current number of weeks of inventories on hand divided by the average number of weeks of inventories on hand during the current period over the data period. To allow for a more continuous graph, extrapolation between estimated values was used for the month and contract dimensions (the contract dimension referrs to number of months from maturity). Trading months are on the left bottom axis of Figure 9.1 and months from maturity are on the right side. Being based on the estimated coefficients Figure 9.1 does not allow for possible estimation error.

When comparing different periods from maturity for the same month, generally the stock effect for the more distant contract is greater. Thus, resulting in the general tilt of the graph downward toward the foreground. The implication being that the more distant contract has a larger basis residual. Simple application of storage theory would

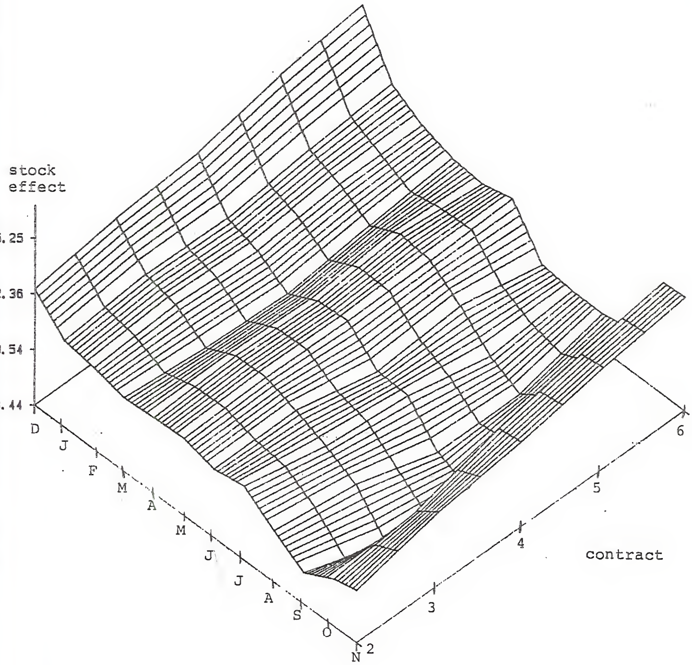

Figure 9.1. Stock effects across the year and across contracts

suggest that this result is due to the risk premium. That is the basis for the more distant contract is bid up relatively more to induce the carrying of stocks a longer length of time. As explained throughly in Chapter VIII and reviewed next, differences in the stock also reflect seasonal influences such as the freeze bias. At lower stock levels a similiar graph would show a decrease in the stock effect for the more distant contract for certain months due to the convenience yield.

If there did not exist any seasonal differences and a level of stocks was portrayed where the net impact on the basis residual of the convenience yield and risk premium was zero, the a graph similiar to Figure 9.1 would be flat--not changing across months or contracts.

In comparing the same model (number of months from maturity) across the year, Figure 9.1, the impact of stocks on the basis generally decreases from December to approximately September and then increase until it peaks in December. Exceptions to this tendency exist for some models, especially from March through May; however, they are not significant.

As an aid in considering how a particular futures contract will tend to act across the year consider Figure 9.2. Figure 9.2 is simply a reproduction of the graph used in Figure 9.1 with two lines added to represent the path of the stock effects for two contracts as they approach

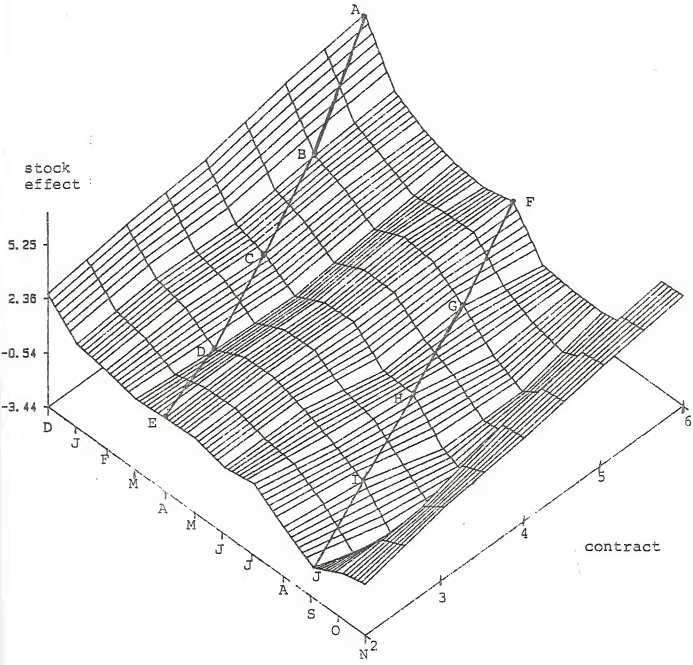

Figure 9.2. Representation of two contracts approaching maturity

termination. Point A represents the stock effect for a contract six months from maturity, point B is the stock effect for the same contract five months from maturity, point C at four months, point D at three months, and point E at two months. The impact of stocks for this example decreases from December (point A) through March (point D). A slight increase occurs in April. Repeating this exercise using points F (May) through J (September) also reveals a general decrease in the stock effect as maturity approaches. Considering both exercises together implies, as shown using examples in Chapter VIII, that the basis residual tends to narrow from approximately December through September. Also, this narrowing is more pronounced at higher stock levels. At lower stock levels the basis residual may widen slightly from about March through July due to the convenience yield. The stock effect increases in October and November, peaking in December, regardless of the level of stocks.

The asymptotic properties of the stock effect implies that an increase in stocks will have less of an impact on the basis than a decrease in stocks. An S{t} value of 0.8 when compared to an S{t} value of 1.0, which was used in Figures 9.1 and 9.2, would result in the stock effect from about June to September decreasing considerably more than the larger winter and pre-winter values. Differences in basis residual values across the season would increase. Correspondingly an S{t} value of 1.2 would result in the

June to September stock effect increasing more. Differences in basis residual values across the season would decrease.

The above implies that imports will tend to result in a decrease in seasonal variations of the basis residual when imports are used to increase inventories. Consider, for example, a freeze that would ordinarily lower S{t} to 0.8 but would result in an S{t} value of 0.9 with increased import availability. Increased importing would increase basis residual values throughout the year but the increase would be greatest from about June to September, which is the period when the basis is apt to be lowest. The result is a narrowing in seasonal differences (compare Figure 8.13 to Figure 8.14).

Hedging Strategies

In reviewing hedging strategies, let us restrict our concept of hedging to include those interests that use the futures market to decrease risk. As explained in Chapter I, the long hedger is one who buys forward and the short hedger sells forward. A narrowing of the basis is to the advantage of the short hedger, while a widening of the basis is to the advantage of the long hedger. The rationale behind hedging strategies is simple. If the basis is expected to narrow, then potential short hedgers should consider using the futures market as long as it corresponds with their stock positions and needs. Long hedgers would consider hedging when the basis is expected to widen. The strategies

reviewed here are based on the estimated results that are the most significant.

A widening of the basis is likely from October through December and can be used to the advantage of potential long hedgers. Short hedging interests will tend to be served by not making a commitment during this interseasonal period. To take maximum advantage of the widening of the basis, long hedgers should reverse their positions in winter when stocks are high, thus potentially avoiding probable future declines in the basis. The eventual decline at high stock levels, implies that committed short hedgers will usually be better served by waiting until winter passes to get out once a widening has occurred. Due to the convenience yield at low stock levels, the basis may continue to widen through May or June. Long hedgers that make commitments during the October-December period may consider waiting until May or June to reverse their positions when stocks are low, though this potential, additional widening is minor compared to the rise in the basis from October through December.

Generally, some decrease in the basis can be expected from December through March that could be used to the advantage of short hedgers by selling forward in December or January. At higher stock levels, this decrease can be expected to continue until September. Thus, at higher stock levels, short hedgers can consider maintaining their positions throughout this period as needed. At lower stock

levels basis movements from March to September are less certain. Without additional information, short hedgers should reverse their postions around March when stocks are low. Short hedging interests that are not able to sell short during winter, can still take advantage of the narrowing basis at high stock levels up until September.

Hedgers today must consider import conditions. Theoretically, one would expect a major change in imports to most likely occur following a significant shift in fundamental conditions such as a major Florida freeze or a dramatic change in the Brazilian crop. If conditions have not changed significantly, then it is reasonable to expect imports to continue as in the recent past. After a major shift in conditions, determining the implications for stocks is difficult. Greater prediction error is likely to occur. Such a shift will most likely effect both U.S. and Brazilian prices. The amount imported is ultimately a function of the spread between these prices, which is a function of the supply conditions and demand conditions throughout the world.

Futures trading following a freeze or a major shift in Brazilian conditions will be based on less information and is thus risky in this respect. Traders not familiar with world citrus conditions should be very cautious before making any futures commitments during such periods.

Hedgers that are using the futures market when a freeze occurs are afforded similiar protection as in periods of less importing. Imports, by providing an alternative to fruit lost to a freeze, will tend to result in less of an increase in U.S. prices and less of a decrease in inventories relative to periods of less importing. The implication for hedgers concerned about basis spreads lies in the effect of imports on stocks. The market will display more of a risk premium effect in post-freeze periods today because stocks are less likely to fall as low. The basis, however, will not necessarily tend to narrow. Rather, the market may be inverted due to relatively low stock levels with the basis widening over time. The increase in stocks associated with imports suggests that this widening will tend to be less.

Expectations and Forecasting

To serve as a hedging tool the basis must be somewhat predictable, especially the direction of basis movements. The existence of seasonal tendencies in FCOJ basis movements generally increases the potential usefulness of the FCOJ futures market to hedging interests. In this section a review of the predictability of basis patterns is presented, the role of the lagged basis residual variable is analyzed, possible simulation exercises discussed, followed by a note on the importance of stable parameters.

R-Squared and its Implications

The final constant period models, Table 7.4, have R^2 values varying from 0.64 to 0.82. Such R^2 values are very high for basis residual models. The implication being that FCOJ basis movements are relatively easy to predict. Comparison of the predicted to the actual basis residual values over the data period , Figures 7.3 through 7.6, further attest to the predictablity of the basis. The estimated models track the actual basis residuals quite well, including turning points. Thus, the FCOJ futures market can be used to the advantage of potential hedging interests.

The Lagged Basis Residual Variable

The final constant period models, Table 7.4, included a lagged basis residual variable that has a very significant impact. Generally, a lagged dependent variable measures rigidities or habit persistence. Evidentally, the FCOJ basis residual does not fully react immediately to changing conditions. An important consideration in understanding this rigidity are transaction costs. Costs associated with making a futures commitment will tend to limit futures trading. Potential traders can not and do not react to every development in the industry immediately. Given a change in conditions, the basis residual will tend to react gradually over time. Such a reaction lessens the impact of transitory changes and thus lessens transaction costs.

The impact of the lagged basis residual is stronger further from maturity, though the impact appears to be approaching some asymptote for the more distant contracts. Thus, the further from maturity the more rigid the FCOJ basis residual. Apparently traders of the more distant contracts are more willing to maintain their positions when faced with daily fluctuations in conditions. As maturity approaches, committed traders are more likely to react quickly to unexpected developments because they wish to get out before the termination date. The constraint of approaching contract maturity accentuates the ramifications of recent developments impacting the basis.

Simulating Basis Residual Adjustments

The orientation of this study has been more theoritical in nature. That is the concern for the predictive capability of the estimated models has only been secondary. Nevertheless, the final constant period models, Table 7.4, could be used to investigate the implications of possible sets of circumstances and to predict basis residual values.

In predicting basis residual values relative stocks represents the primary unknown among the explanatory variables. The crop forecast will tend to remain quite stable across the season unless a freeze occurs. Generally, current relative stock levels is the most useful tool in predicting future stock levels. When available data on predicted imports, total processor sales (including

exports), and pack of Florida fruit could be used to predict future inventory levels (pack plus imports minus processor sales equals the change in inventories). One, generally, will not need the exact stock level to use the model. The primary concern of most potential users is if the basis will narrow or widen. Slight differences in the stock level used will not usually change the direction of basis movements. The current generated predicted basis residual value would be used as the lagged basis residual value for the following month.

Simulation exercises would be conducted similarly, using the set of explanatory values and the lagged predicted basis residual value. Mean market liquidity values, Table 7.5, would probably be employed since the impact of the market liquidity variable is negligible. Analysis could follow one contract as it approaches maturity by using the results of the six month simulation six months from maturity, the five month from maturity simulation five months from maturity, etc. as done in Figures 8.13 through 8.15.

Importance of Stable Parameters

An important implication for traders in their use of the FCOJ futures market of stable basis residual parameters is that they can be assured that the basis will react similiarly in the future as it has in the past. Though, clearly stock adjustments following a freeze will vary in accordance with import conditions. Models developed in this

study or similiar models can be used to guide future decisions. Surely, there is some chance that this stability may change. However, considering the dramatic changes in the industry during the data period employed in this study future stability appears assured.

CHAPTER X

SUMMARY, CONCLUSIONS, AND RESEARCH SUGGESTIONS

This chapter includes a summary of the research conducted, a statement of the conclusions reached, and suggestions for future research.

Summary

The overall objective of this study was to investigate FCOJ basis residual movements. Various models were estimated with an emphasis on identifying any seasonal pattern in basis movements. The possibility that FCOJ basis residual patterns have changed in recent years due to increased importing and other developments within the industry was also investigated.

The Ward-Dasse model, which depicts basis residual patterns based on spot fruit prices and was originally estimated before the import expansion, was updated and estimated over the original and an expanded data period. It was hoped that by comparing the estimated coefficients of these two estimates some insight would be gained into how the impact of explanatory variables on the basis residual have changed. Estimation problems, notably difficulties in

indexing, prevented a firm conclusion as to coefficient adjustments from being reached.

To allow for estimates using time varying parameters, basis residual models were specified based on a constant period from maturity as opposed to a constant contract approach such as Ward-Dasse's model of the July contract basis residual. Time varying parameter estimates using a constant contract approach are not possible because the data are discontinuous. Another benefit of the constant period from maturity model is that basis residual movements across the entire year are considered. The Ward-Dasse model only runs from December to July.

The constant contract models were estimated using the FOB bulk price as the basis cash price. A noteable feature of these models is the treatment of theoretical concepts of convenience yield and risk premium, both functions of stocks.

The existence of seasonal tendencies in basis residual patterns presented the most difficult estimation problems. This problem was overcome by interacting the stock variable with a set of monthly dummy variables. Time varying parameter estimates using several different model specifications pointed to no change in parameters over time.

Conclusions

The impact of economic factors addressed by traditional storage theory and also those unique to the citrus industry

have not changed significantly during recent years in determining basis residual movements. Imports considered in isolation have had no impact on basis residual patterns. The role of imports is limited to the influence they have over the level of stocks carried by processors. Increased import availability will result in less of a decrease in stocks following a freeze and thus also result in less of a decrease in the basis.

A tendency for the basis residual to dip towards the end of the season has been identified. If futures prices reflect an anticipated price decrease the next season, the residual will tend to widen from October to December. A widening of the basis from October through December is also likely due to the freeze bias, regardless of interseasonal price adjustments. Such a widening of the basis can be used to the advantage of long hedgers.

The impact of stocks varies across the year and influences seasonal basis patterns. A larger dip in the basis residual towards the end of the season is likely when stocks are low. The freeze bias results in stocks having a more positive impact on the basis in winter and pre-winter months.

The FCOJ futures market performs as predicted by theory. Basis movements within the season will tend to narrow over time when stock levels are high. A widening of the basis over time is more likely at low stock levels. Thus, the

evidence implies that FCOJ futures trading responds efficiently to market conditions.

Suggestions for Research

The importance of stocks in determining basis residual movements suggests that traders would benefit from a delineation of the determinants of stock levels. Such an approach would be most useful if it was to include supply conditions in Florida and Brazil. The stock response following a freeze would be of particular interest, as would the role of imports following freezes.

Increased understanding and quantification of interseasonal price changes would be useful in the decision making process for the industry generally as well as futures traders. since many are in a position to profit from swings in juice values. Models both in and out of a futures context would be useful.

A topic related to both interseasonal price changes and stocks carried is crop expectations for the following season. Citrus literature does not address this expectation. This lack of attention results from the U.S.D.A. crop forecast not being released until October. Yet, clearly anticipated crop for the next season has some impact on current prices, especially towards the end of the season. Research of crop expectations before October would be useful. At the least, regression analysis of actual initial crop forecasts against such variables as the size of

the current crop, extent of freezes during the current season, percentage increase in crop in recent years, total rainfall for the current season, and years since the last freeze might prove useful. The results of such an exercise could be used in generating a proxy variable for the expected crop forecast.

The constant period models estimated here demonstrate the importance of allowing for seasonal differences in basis residual patterns. When these differences are not accounted for, the estimated results change considerably. Most similar research reported for other commodities does not make allowances for possible seasonal differences. Generally, the research plan for any commodity should include the investigation of possible seasonal differences.

In analyzing basis residual patterns, the researcher should be aware of the advantages of using a constant period or constant contract approach for the commodity in question. Some differences were discussed in Chapter VII. Conducting research using both approaches may suggest changes in specification that more accurately represent the process involved. Each approach provides a different perspective of one phenomenon. If the estimated results differ significantly, then examination may reveal a more plausible specification.

APPENDIX A

TIME VARYING PARAMETER RESULTS

Many time varying parameter models were estimated, each suggesting no change in parameters overtime. The time varying parameter results for the four month from maturity model as specified in Table 7.4 (the final model) are reviewed here. The four month from maturity model was selected for review because it is an intermediate period of time from maturity. These results are presented only as a means of documentation. Given that the structure is not changing (that is the index of permanent parameter adjustment, θ^*, equals zero), then ordinary least squares is the preferred estimation procedure. Thus, additional time varying parameter results are not reviewed.

Table A.1 displays the estimated coefficients for the four month from maturity model when estimated using Cooley-Prescott's time varying parameter procedure. The data period used runs from October, 1973 through November, 1982. The seasonal pattern of the DSTK variables is similar to that obtained using ordinary least squares (Table 7.4).

Estimation entails selecting the value of the index of permanent parameter adjustment that maximizes the likelihood

Table A.1. Time varying parameter results for the four month model

Variable	Coefficient	t-statistic
Intercept	7.2601	2.3050
RP{t}	-0.0040	-0.3233
ML4{t}	-0.0030	-0.6422
FZ{t}	-0.0036	-0.0110
BR4{t-1}	0.6402	7.7805
INVSTK{t}	-3.5432	-1.7606
DSTK12	2.2322	1.7484
DSTK1	0.0938	0.0648
DSTK2	0.6898	0.5462
DSTK3	-1.3297	-1.0506
DSTK4	-0.3794	-0.3034
DSTK6	-1.1390	-0.8648
DSTK7	-2.1123	-1.6478
DSTK8	-3.2825	-2.6538
DSTK9	-4.0447	-3.1516
DSTK10	0.9193	0.7045
DSTK11	0.06872	0.0562

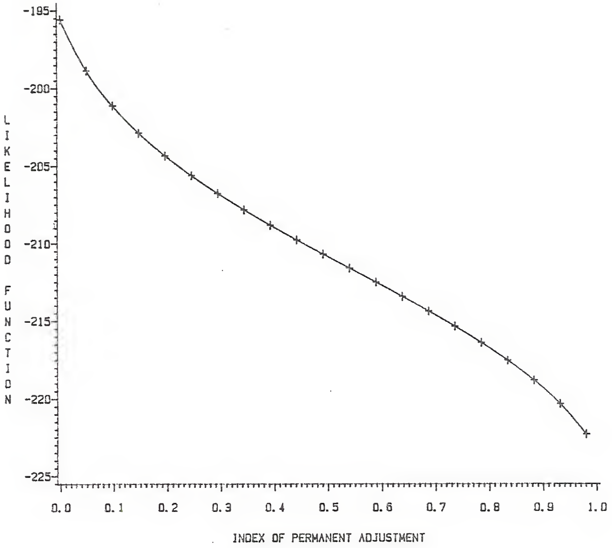

Figure A.1. Likelihood function values for different values of the index of permanent parameter adjustment

function. Figure A.1 shows the different values of the likelihood function for different values of the index of permanent parameter adjustment. The likelihood function is maximized when the index of permanent parameter adjustment equals zero--that is all errors are transitory.

APPENDIX B

COVARIANCE MATRICES

Tables B.1 through B.5 contain the covariance matrices associated with the models' estimated coefficients reviewed in Table 7.4. For simplicity the coefficients are denoted by the variable to which they refer; addressed is the covariance matrix of the estimated coefficients. Note that the subscripts have been omitted. The coefficient associated with BR6(t-1) is denoted I1BR6, the coefficient associated with BR5(t-1) is denoted I1BR5, etc.

Table B.1. Covariance matrix for the six month model

	INTERCEP	ML6	RP	FZ	L1BR6
INTERCEP	6.92270	0.0032	-0.0193	0.0606	-0.0594
ML6	0.00324	0.0002	-0.0000	-0.0000	0.0000
RP	-0.01926	-0.0000	0.0001	-0.0004	-0.0000
FZ	0.06056	-0.0000	-0.0004	0.0814	0.0005
L1BR6	-0.05936	0.0000	-0.0000	0.0005	0.0027
INVSTK	-3.36850	-0.0031	0.0044	-0.0002	0.0478
DSTK12	0.20009	-0.0014	-0.0009	-0.0223	0.0038
DSTK1	0.17979	-0.0004	0.0001	-0.1213	-0.0068
DSTK2	0.21883	0.0008	-0.0002	-0.0005	-0.0068
DSTK3	0.11100	0.0008	0.0001	-0.0121	-0.0056
DSTK4	0.11216	-0.0008	0.0001	-0.0009	-0.0043
DSTK6	-0.11131	-0.0020	0.0002	0.0008	0.0014
DSTK7	-0.20441	0.0009	-0.0002	0.0017	0.0085
DSTK8	-0.26896	0.0000	-0.0002	0.0026	0.0126
DSTK9	-0.37759	0.0013	-0.0004	0.0033	0.0181
DSTK10	-0.21752	0.0013	-0.0010	0.0057	0.0188
DSTK11	0.09704	-0.0001	-0.0011	0.0055	0.0092

Table B.1--continued

	INVSTK	DSTK12	DSTK1	DSTK2	DSTK3	DSTK4
INTERCEP	-3.3685	0.2001	0.1798	0.2188	0.1110	0.1122
ML6	-0.0031	-0.0014	-0.0004	0.0008	0.0008	-0.0008
RP	0.0044	-0.0009	0.0001	-0.0002	0.0001	0.0001
FZ	-0.0002	-0.0223	-0.1213	-0.0005	-0.0121	-0.0009
L1BR6	0.0478	0.0038	-0.0068	-0.0068	-0.0056	-0.0043
INVSTK	2.9098	-0.6280	-0.7293	-0.7390	-0.6968	-0.6790
DSTK12	-0.6280	1.1960	0.6219	0.5720	0.5738	0.5879
DSTK1	-0.7293	0.6219	1.3605	0.6012	0.6136	0.5986
DSTK2	-0.7390	0.5720	0.6012	1.1926	0.6032	0.5929
DSTK3	-0.6968	0.5738	0.6136	0.6032	1.1881	0.5913
DSTK4	-0.6790	0.5879	0.5986	0.5929	0.5913	1.1569
DSTK6	-0.4886	0.6010	0.5851	0.5720	0.5737	0.5910
DSTK7	-0.4164	0.5891	0.5624	0.5681	0.5716	0.5682
DSTK8	-0.3587	0.6042	0.5545	0.5539	0.5595	0.5661
DSTK9	-0.2780	0.6021	0.5385	0.5457	0.5534	0.5523
DSTK10	-0.3371	0.6123	0.5378	0.5458	0.5514	0.5520
DSTK11	-0.5444	0.6175	0.5653	0.5642	0.5644	0.5740

Table B.1--continued

	DSTK6	DSTK7	DSTK8	DSTK9	DSTK10	DSTK11
INTERCEP	-0.1113	-0.2044	-0.2690	-0.3776	-0.2175	0.0970
ML6	-0.0020	0.0009	0.0000	0.0013	0.0013	-0.0001
RP	0.0002	-0.0002	-0.0002	-0.0004	-0.0010	-0.0011
FZ	0.0008	0.0017	0.0026	0.0033	0.0057	0.0055
L1BR6	0.0014	0.0085	0.0126	0.0181	0.0188	0.0092
INVSTK	-0.4886	-0.4164	-0.3587	-0.2780	-0.3371	-0.5444
DSTK12	0.6010	0.5891	0.6042	0.6021	0.6123	0.6175
DSTK1	0.5851	0.5624	0.5545	0.5385	0.5378	0.5653
DSTK2	0.5720	0.5681	0.5539	0.5457	0.5458	0.5642
DSTK3	0.5737	0.5716	0.5595	0.5534	0.5514	0.5644
DSTK4	0.5910	0.5682	0.5661	0.5523	0.5520	0.5740
DSTK6	1.2239	0.5826	0.5936	0.5836	0.5820	0.5909
DSTK7	0.5826	1.2371	0.6243	0.6464	0.6478	0.6112
DSTK8	0.5936	0.6243	1.2395	0.6683	0.6718	0.6286
DSTK9	0.5836	0.6464	0.6683	1.3161	0.7167	0.6451
DSTK10	0.5820	0.6478	0.6718	0.7167	1.2963	0.6570
DSTK11	0.5909	0.6112	0.6286	0.6451	0.6570	1.1657

Table B.2. Covariance matrix for the five month model

	INTERCEP	ML5	RP	FZ	L1BR5
INTERCEP	6.44978	0.0039	-0.0178	0.0559	-0.0609
ML5	0.00387	0.0000	-0.0000	0.0000	-0.0000
RP	-0.01783	-0.0000	0.0001	-0.0004	-0.0000
FZ	0.05594	0.0000	-0.0004	0.0722	0.0006
L1BR5	-0.06094	-0.0000	-0.0000	0.0006	0.0031
INVSTK	-3.05383	-0.0020	0.0041	-0.0016	0.0453
DSTK12	0.10896	-0.0002	-0.0010	-0.0193	0.0078
DSTK1	0.08515	-0.0003	0.0001	-0.1077	-0.0043
DSTK2	0.11935	-0.0002	-0.0001	-0.0003	-0.0047
DSTK3	0.04406	-0.0001	0.0002	-0.0108	-0.0044
DSTK4	0.04418	-0.0002	0.0001	-0.0009	-0.0018
DSTK6	-0.12700	-0.0005	0.0002	-0.0000	0.0022
DSTK7	-0.32804	-0.0016	0.0005	-0.0001	0.0071
DSTK8	-0.26549	-0.0003	-0.0001	0.0025	0.0126
DSTK9	-0.44665	-0.0003	-0.0002	0.0042	0.0217
DSTK10	-0.32827	-0.0004	-0.0008	0.0063	0.0230
DSTK11	-0.01315	-0.0003	-0.0010	0.0057	0.0135

Table B.2--continued

	INVSTK	DSTK12	DSTK1	DSTK2	DSTK3	DSTK4
INTERCEP	-3.0538	0.1090	0.0851	0.1194	0.0441	0.0442
ML5	-0.0020	-0.0002	-0.0003	-0.0002	-0.0001	-0.0002
RP	0.0041	-0.0010	0.0001	-0.0001	0.0002	0.0001
FZ	-0.0016	-0.0193	-0.1077	-0.0003	-0.0108	-0.0009
L1BR5	0.0453	0.0078	-0.0043	-0.0047	-0.0044	-0.0018
INVSTK	2.5197	-0.5190	-0.5930	-0.5928	-0.5720	-0.5639
DSTK12	-0.5190	1.0657	0.5479	0.5105	0.5107	0.5174
DSTK1	-0.5930	0.5479	1.1999	0.5277	0.5408	0.5246
DSTK2	-0.5928	0.5105	0.5277	1.0461	0.5264	0.5232
DSTK3	-0.5720	0.5107	0.5408	0.5264	1.0468	0.5229
DSTK4	-0.5639	0.5174	0.5246	0.5232	0.5229	1.0190
DSTK6	-0.4338	0.5245	0.5207	0.5185	0.5187	0.5204
DSTK7	-0.3053	0.5415	0.5246	0.5170	0.5173	0.5244
DSTK8	-0.3183	0.5521	0.5036	0.5012	0.5023	0.5128
DSTK9	-0.1834	0.5739	0.4898	0.4868	0.4890	0.5067
DSTK10	-0.2216	0.5863	0.4903	0.4870	0.4871	0.5076
DSTK11	-0.4243	0.5689	0.5039	0.5020	0.4997	0.5139

Table B.2--continued

	DSTK6	DSTK7	DSTK8	DSTK9	DSTK10	DSTK11
INTERCEP	-0.1270	-0.3280	-0.2655	-0.4467	-0.3283	-0.0132
ML5	-0.0005	-0.0016	-0.0003	-0.0003	-0.0004	-0.0003
RP	0.0002	0.0005	-0.0001	-0.0002	-0.0008	-0.0010
FZ	-0.0000	-0.0001	0.0025	0.0042	0.0063	0.0057
L1BR5	0.0022	0.0071	0.0126	0.0217	0.0230	0.0135
INVSTK	-0.4338	-0.3053	-0.3183	-0.1834	-0.2216	-0.4243
DSTK12	0.5245	0.5415	0.5521	0.5739	0.5863	0.5689
DSTK1	0.5207	0.5246	0.5036	0.4898	0.4903	0.5039
DSTK2	0.5185	0.5170	0.5012	0.4868	0.4870	0.5020
DSTK3	0.5187	0.5173	0.5023	0.4890	0.4871	0.4997
DSTK4	0.5204	0.5244	0.5128	0.5067	0.5076	0.5139
DSTK6	1.0733	0.5489	0.5314	0.5365	0.5380	0.5290
DSTK7	0.5489	1.1600	0.5587	0.5753	0.5825	0.5557
DSTK8	0.5314	0.5587	1.1004	0.6087	0.6148	0.5755
DSTK9	0.5365	0.5753	0.6087	1.2077	0.6813	0.6139
DSTK10	0.5380	0.5825	0.6148	0.6813	1.2003	0.6284
DSTK11	0.5290	0.5557	0.5755	0.6139	0.6284	1.0646

Table B.3. Covariance matrix for the four month model

	INTERCEP	ML4	RP	FZ	L1BR4
INTERCEP	5.06712	0.0016	-0.0140	0.0457	-0.0511
ML4	0.00161	0.0000	-0.0000	0.0000	-0.0000
RP	-0.01399	-0.0000	0.0001	-0.0003	-0.0001
FZ	0.04572	0.0000	-0.0003	0.0607	0.0008
L1BR4	-0.05112	-0.0000	-0.0001	0.0008	0.0034
INVSTK	-2.35476	-0.0009	0.0028	-0.0001	0.0392
DSTK12	0.10351	0.0001	-0.0010	-0.0148	0.0093
DSTK1	0.07094	-0.0001	0.0001	-0.0906	-0.0039
DSTK2	0.06065	-0.0004	0.0001	-0.0014	-0.0044
DSTK3	0.03646	-0.0001	0.0002	-0.0094	-0.0044
DSTK4	0.03879	-0.0001	0.0001	-0.0008	-0.0014
DSTK6	-0.12236	-0.0007	0.0003	-0.0017	0.0008
DSTK7	-0.18831	-0.0006	0.0001	-0.0002	0.0058
DSTK8	-0.12088	-0.0000	-0.0002	0.0023	0.0084
DSTK9	-0.27780	-0.0001	-0.0004	0.0041	0.0176
DSTK10	-0.27242	-0.0003	-0.0010	0.0071	0.0248
DSTK11	0.00332	0.0000	-0.0011	0.0066	0.0153

Table B.3--continued

	INVSTK	DSTK12	DSTK1	DSTK2	DSTK3	DSTK4
INTERCEP	-2.3548	0.1035	0.0709	0.0607	0.0365	0.0388
ML4	-0.0009	0.0001	-0.0001	-0.0004	-0.0001	-0.0001
RP	0.0028	-0.0010	0.0001	0.0001	0.0002	0.0001
FZ	-0.0001	-0.0148	-0.0906	-0.0014	-0.0094	-0.0008
L1BR4	0.0392	0.0093	-0.0039	-0.0044	-0.0044	-0.0014
INVSTK	1.9866	-0.4355	-0.4946	-0.4745	-0.4790	-0.4717
DSTK12	-0.4355	0.9028	0.4553	0.4224	0.4241	0.4324
DSTK1	-0.4946	0.4553	1.0040	0.4445	0.4527	0.4382
DSTK2	-0.4745	0.4224	0.4445	0.8862	0.4427	0.4391
DSTK3	-0.4790	0.4241	0.4527	0.4427	0.8777	0.4375
DSTK4	-0.4717	0.4324	0.4382	0.4391	0.4375	0.8530
DSTK6	-0.3589	0.4300	0.4417	0.4543	0.4384	0.4380
DSTK7	-0.3021	0.4445	0.4348	0.4455	0.4313	0.4353
DSTK8	-0.3349	0.4584	0.4252	0.4242	0.4241	0.4313
DSTK9	-0.2190	0.4824	0.4155	0.4148	0.4129	0.4278
DSTK10	-0.1798	0.5085	0.4095	0.4105	0.4037	0.4263
DSTK11	-0.3562	0.4903	0.4184	0.4157	0.4140	0.4298

Table B.3--continued

	DSTK6	DSTK7	DSTK8	DSTK9	DSTK10	DSTK11
INTERCEP	-0.1224	-0.1883	-0.1209	-0.2778	-0.2724	0.0033
ML4	-0.0007	-0.0006	-0.0000	-0.0001	-0.0003	0.0000
RP	0.0003	0.0001	-0.0002	-0.0004	-0.0010	-0.0011
FZ	-0.0017	-0.0002	0.0023	0.0041	0.0071	0.0066
L1BR4	0.0008	0.0058	0.0084	0.0176	0.0248	0.0153
INVSTK	-0.3589	-0.3021	-0.3349	-0.2190	-0.1798	-0.3562
DSTK12	0.4300	0.4445	0.4584	0.4824	0.5085	0.4903
DSTK1	0.4417	0.4348	0.4252	0.4155	0.4095	0.4184
DSTK2	0.4543	0.4455	0.4242	0.4148	0.4105	0.4157
DSTK3	0.4384	0.4313	0.4241	0.4129	0.4037	0.4140
DSTK4	0.4380	0.4353	0.4313	0.4278	0.4263	0.4298
DSTK6	0.9310	0.4717	0.4367	0.4435	0.4515	0.4333
DSTK7	0.4717	0.9380	0.4494	0.4692	0.4872	0.4565
DSTK8	0.4367	0.4494	0.8988	0.4786	0.4966	0.4732
DSTK9	0.4435	0.4692	0.4786	0.9754	0.5644	0.5133
DSTK10	0.4515	0.4872	0.4966	0.5644	1.0459	0.5523
DSTK11	0.4333	0.4565	0.4732	0.5133	0.5523	0.9116

Table B.4. Covariance matrix for the three month model

	INTERCEP	ML3	RP	FZ	L1BR3
INTERCEP	3.73958	0.0002	-0.0104	0.0336	-0.0432
ML3	0.00016	0.0000	-0.0000	0.0000	-0.0000
RP	-0.01041	-0.0000	0.0001	-0.0002	-0.0001
FZ	0.03359	0.0000	-0.0002	0.0481	0.0008
L1BR3	-0.04322	-0.0000	-0.0001	0.0008	0.0040
INVSTK	-1.66866	-0.0003	0.0019	0.0006	0.0311
DSTK12	0.05702	0.0001	-0.0009	-0.0113	0.0118
DSTK1	0.05698	-0.0000	0.0001	-0.0714	-0.0032
DSTK2	0.06715	-0.0006	-0.0000	-0.0007	-0.0041
DSTK3	0.03350	-0.0001	0.0002	-0.0075	-0.0046
DSTK4	0.03127	0.0000	0.0000	-0.0004	-0.0010
DSTK6	-0.03350	-0.0006	0.0000	-0.0002	0.0003
DSTK7	-0.04557	0.0000	-0.0001	0.0007	0.0022
DSTK8	-0.05270	0.0001	-0.0002	0.0013	0.0053
DSTK9	-0.13156	-0.0000	-0.0003	0.0026	0.0117
DSTK10	-0.14459	-0.0002	-0.0009	0.0059	0.0221
DSTK11	-0.01208	0.0001	-0.0011	0.0059	0.0176

Table B.4--continued

	INVSTK	DSTK12	DSTK1	DSTK2	DSTK3	DSTK4
INTERCEP	-1.6687	0.0570	0.0570	0.0672	0.0335	0.0313
ML3	-0.0003	0.0001	-0.0000	-0.0006	-0.0001	0.0000
RP	0.0019	-0.0009	0.0001	-0.0000	0.0002	0.0000
FZ	0.0006	-0.0113	-0.0714	-0.0007	-0.0075	-0.0004
L1BR3	0.0311	0.0118	-0.0032	-0.0041	-0.0046	-0.0010
INVSTK	1.4307	-0.3356	-0.3868	-0.3699	-0.3779	-0.3725
DSTK12	-0.3356	0.7303	0.3605	0.3302	0.3320	0.3434
DSTK1	-0.3868	0.3605	0.7936	0.3509	0.3580	0.3461
DSTK2	-0.3699	0.3302	0.3509	0.7241	0.3527	0.3452
DSTK3	-0.3779	0.3320	0.3580	0.3527	0.6966	0.3460
DSTK4	-0.3725	0.3434	0.3461	0.3452	0.3460	0.6756
DSTK6	-0.3069	0.3402	0.3468	0.3750	0.3478	0.3435
DSTK7	-0.3066	0.3502	0.3424	0.3412	0.3420	0.3437
DSTK8	-0.3027	0.3612	0.3402	0.3356	0.3382	0.3435
DSTK9	-0.2458	0.3794	0.3353	0.3328	0.3312	0.3417
DSTK10	-0.1998	0.4145	0.3287	0.3343	0.3198	0.3394
DSTK11	-0.2826	0.4077	0.3318	0.3249	0.3232	0.3417

Table B.4--continued

	DSTK6	DSTK7	DSTK8	DSTK9	DSTK10	DSTK11
INTERCEP	-0.0335	-0.0456	-0.0527	-0.1316	-0.1446	-0.0121
ML3	-0.0006	0.0000	0.0001	-0.0000	-0.0002	0.0001
RP	0.0000	-0.0001	-0.0002	-0.0003	-0.0009	-0.0011
FZ	-0.0002	0.0007	0.0013	0.0026	0.0059	0.0059
L1BR3	0.0003	0.0022	0.0053	0.0117	0.0221	0.0176
INVSTK	-0.3069	-0.3066	-0.3027	-0.2458	-0.1998	-0.2826
DSTK12	0.3402	0.3502	0.3612	0.3794	0.4145	0.4077
DSTK1	0.3468	0.3424	0.3402	0.3353	0.3287	0.3318
DSTK2	0.3750	0.3412	0.3356	0.3328	0.3343	0.3249
DSTK3	0.3478	0.3420	0.3382	0.3312	0.3198	0.3232
DSTK4	0.3435	0.3437	0.3435	0.3417	0.3394	0.3417
DSTK6	0.7379	0.3444	0.3415	0.3460	0.3576	0.3416
DSTK7	0.3444	0.7126	0.3482	0.3518	0.3565	0.3537
DSTK8	0.3415	0.3482	0.7034	0.3606	0.3730	0.3689
DSTK9	0.3460	0.3518	0.3606	0.7356	0.4102	0.3966
DSTK10	0.3576	0.3565	0.3730	0.4102	0.8102	0.4470
DSTK11	0.3416	0.3537	0.3689	0.3966	0.4470	0.7463

Table B.5. Covariance matrix for the two month model

	INTERCEP	ML2	RP	FZ	L1BR2
INTERCEP	2.55774	0.0003	-0.0074	0.0259	-0.0297
ML2	0.00035	0.0000	-0.0000	0.0000	-0.0000
RP	-0.00741	-0.0000	0.0000	-0.0002	-0.0001
FZ	0.02591	0.0000	-0.0002	0.0344	0.0007
L1BR2	-0.02968	-0.0000	-0.0001	0.0007	0.0043
INVSTK	-1.09394	-0.0003	0.0014	-0.0014	0.0190
DSTK12	0.04466	0.0000	-0.0008	-0.0074	0.0130
DSTK1	0.02528	-0.0000	0.0000	-0.0511	-0.0017
DSTK2	0.02425	-0.0002	-0.0000	-0.0005	-0.0018
DSTK3	0.01148	0.0000	0.0002	-0.0052	-0.0034
DSTK4	0.02639	0.0000	0.0000	-0.0004	-0.0016
DSTK6	-0.01718	0.0000	-0.0000	0.0001	0.0003
DSTK7	-0.02995	-0.0000	-0.0001	0.0005	0.0020
DSTK8	-0.00389	0.0000	-0.0001	0.0005	0.0013
DSTK9	-0.04880	-0.0000	-0.0002	0.0014	0.0068
DSTK10	-0.02987	-0.0001	-0.0007	0.0034	0.0142
DSTK11	0.00543	-0.0003	-0.0009	0.0034	0.0153

Table B.5--continued

	INVSTK	DSTK12	DSTK1	DSTK2	DSTK3	DSTK4
INTERCEP	-1.0939	0.0447	0.0253	0.0243	0.0115	0.0264
ML2	-0.0003	0.0000	-0.0000	-0.0002	0.0000	0.0000
RP	0.0014	-0.0008	0.0000	-0.0000	0.0002	0.0000
FZ	-0.0014	-0.0074	-0.0511	-0.0005	-0.0052	-0.0004
L1BR2	0.0190	0.0130	-0.0017	-0.0018	-0.0034	-0.0016
INVSTK	0.9402	-0.2500	-0.2645	-0.2517	-0.2602	-0.2684
DSTK12	-0.2500	0.5372	0.2590	0.2401	0.2373	0.2430
DSTK1	-0.2645	0.2590	0.5671	0.2497	0.2547	0.2475
DSTK2	-0.2517	0.2401	0.2497	0.5014	0.2484	0.2469
DSTK3	-0.2602	0.2373	0.2547	0.2484	0.4968	0.2480
DSTK4	-0.2684	0.2430	0.2475	0.2469	0.2480	0.4838
DSTK6	-0.2326	0.2466	0.2462	0.2462	0.2464	0.2463
DSTK7	-0.2219	0.2516	0.2456	0.2462	0.2451	0.2455
DSTK8	-0.2412	0.2512	0.2456	0.2445	0.2456	0.2463
DSTK9	-0.2127	0.2675	0.2436	0.2428	0.2413	0.2441
DSTK10	-0.2064	0.2935	0.2418	0.2427	0.2352	0.2416
DSTK11	-0.2158	0.2966	0.2452	0.2533	0.2347	0.2409

Table B.5--continued

	DSTK6	DSTK7	DSTK8	DSTK9	DSTK10	DSTK11
INTERCEP	-0.0172	-0.0299	-0.0039	-0.0488	-0.0299	0.0054
ML2	0.0000	-0.0000	0.0000	-0.0000	-0.0001	-0.0003
RP	-0.0000	-0.0001	-0.0001	-0.0002	-0.0007	-0.0009
PZ	0.0001	0.0005	0.0005	0.0014	0.0034	0.0034
L1BR2	0.0003	0.0020	0.0013	0.0068	0.0142	0.0153
INVSTK	-0.2326	-0.2219	-0.2412	-0.2127	-0.2064	-0.2158
DSTK12	0.2466	0.2516	0.2512	0.2675	0.2935	0.2966
DSTK1	0.2462	0.2456	0.2456	0.2436	0.2418	0.2452
DSTK2	0.2462	0.2462	0.2445	0.2428	0.2427	0.2533
DSTK3	0.2464	0.2451	0.2456	0.2413	0.2352	0.2347
DSTK4	0.2463	0.2455	0.2463	0.2441	0.2416	0.2409
DSTK6	0.5057	0.2472	0.2470	0.2473	0.2472	0.2462
DSTK7	0.2472	0.5098	0.2473	0.2501	0.2532	0.2536
DSTK8	0.2470	0.2473	0.4986	0.2490	0.2508	0.2487
DSTK9	0.2473	0.2501	0.2490	0.5124	0.2692	0.2692
DSTK10	0.2472	0.2532	0.2508	0.2692	0.5361	0.3033
DSTK11	0.2462	0.2536	0.2487	0.2692	0.3033	0.5515

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